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Bituminous Surpaced Highway in Wind River Canyon, Wyoming

CONSTRUCTION OF BITUMINOUS SURFACES IN WYOMING

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IN discussing methods of construction of bituminous surfaces for roads I must confine my remarks to those methods as used by the State Highway Department in Wyoming.

Much has been written in the last few years on this subject in regard to the best methods of construction, the proper aggregates and grade of bituminous material that should be used to obtain the best results and we find a great deal of duplication of information in most reports. That great progress has been made in the construction of these surfaces is very evident as can be seen by comparison of road surfaces constructed at this time and the ones constructed some years ago. Fundamental principles of the methods of construction have remained the same but improvement has gradually been made in numerous ways, in the equipment used for such work, the bituminous material, type and grading of aggregates and particularly in the construction of the sub-grades on which the surfaces are to be placed.

As late as 1927 found the highway commission in this state planning the completion of the primary road system to a gravel surface standard by the year 1938 and a program was made accordingly, but it soon became evident on account of the constantly increasing automobile traffic that such road surfaces were unsatisfactory, it being practically impossible to maintain them in proper shape. The increasing number of complaints by users of the highways as to the roughness, loose gravel and dust menace, especially in dry weather brought the realization that a more substantial surface must be provided for the highway system.

72 Per Cent of State Highway System Has Bituminous Surface.—While some experimental work had been done previously it was not until the years 1927 and 1928 that any amount of oiled surfaces were constructed. By the end of 1928 approximately 87 miles of such surfaces were completed, the work being done entirely by state forces. These surfaces proved very satisfactory

Bituminous Surface Through Tunnels, Wind River Canyon, Wyoming

and demands for more roads of the oiled type began to be made of the highway department, so it was decided to proceed with the construction of such surfaces as far as funds were available. Such progress has been made along this line that 2,500 miles or approximately 72 per cent of the state highway system in Wyoming has a bituminous surface, mostly of the road mix type. Prior to 1931 all of such work was done by state forces using equipment on hand except for the purchase of equipment for heating, hauling and applying the oil. While the oiled mats constructed up to this time are not up to the standard of the ones constructed during later years, they have proven very satisfactory and have given good service to the present time and have provided a smooth, dustless, surface for traffic with a great decrease in maintenance costs over the old gravel roads.

Construction of Early Oiled Surfaces.—The early oiled surfaces were constructed by scarifying the surface of the roadway to the depth required to produce aggregate sufficient for the thickness of the required mat. While most of the roads had been surfaced with gravel to a depth of 6 in. as required on all federal aid roads in this state, in many cases a great deal of the material had been lost by wind and traffic erosion at the time of construction of the oiled mats. It naturally followed that in such cases the amount of base surfacing remaining after construction of the oiled surface was thin and sometimes almost negligible. Subgrades were in many cases poorly drained and composed of poor material. Mats were constructed to a width of 18 ft. on gravel bases of the same width, with no provision for gravel shoulders. These narrow mats with insufficient base courses were the source of numerous shoulder breaks and were naturally difficult to maintain.

Improvements have gradually been made in all phases of the construction from the subgrade to the final surface placed on all bituminous surface roads. Present practice requires that only satisfactory material be placed in the subgrade, unsuitable material being removed and wasted and this replaced by suitable material that will provide a stable base. Soil tests are made in the laboratory under the direction of the materials engineer to determine, the suitability or unsuitability of such materials, also on materials to be used as binders of all gravel or crushed rock to be used for base or top course surfacing. Particular attention is paid to see that proper drainage is provided during construction of the subgrades that all water may drain off quickly and wherever possible to prevent standing water in the borrow pits or adjacent to the roadbed.

Road Mix Surfaces.—Base courses of crushed gravel or stone are now provided for full width of the roadway and are thoroughly compacted by sprinkling and rolling before any material for the bituminous surfacing is placed. Except in a few instances where it has been necessary on account of weather conditions to lay the top course gravel and pick it up again at time of construction of the mats no scarifying is done but material for the top course is placed in windrow just ahead of the oiling work.

Mixing is done by use of graders, motor patrols and road mixing machines. The road mix machines have been used to a large extent during the past two years and are considered a great improvement over the use of graders or motor patrols alone, providing as they do for less inconvenience to traffic which necessarily must go over the roads during time of construction. However, specifications still require that oiled material must be thoroughly mixed by graders after passing through the machines.

After mixing the material is laid down shaped to proper cross section and rolled. Seal coat is applied generally with 30 days after completion of the mat. Practically all mats are constructed with thickness of 2½ in. on a gravel base of 3½ in.; some have 3 in. while many state projects on suitable base have 1½ to 2 in. Widths vary from a minimum of 21 ft. to 26 ft. After construction of the mat, gravel shoulders are placed and rolled to same thickness as the mat.

Standard specifications for oil treated gravel or stone surfacing call for crushed or screened gravel or broken stone and sand or combination of these, all of which shall be hard, tough, durable and sound, uniformly graded from fine to coarse, free from thin or elongated pieces and conforming to the following requirements for grading:

Passing ¾-in. sieve	100%
Passing 3-mesh sieve	50-80%
Passing 10-mesh sieve	35-70%
Passing 200-mesh sieve	5-10%

Sand is added to the pit or crusher run product to supply any deficiency in the 10 mesh material and earth

Another View of Surfacing Through Tunnels in Wind River Canyon, Wyoming

Bituminous Surface on Lush-Newcastle Road, Wyoming

or dust filler added to supply any deficiency in the 200 mesh material.

Filler shall have a moisture equivalent of not more than 20 and a lineal shrinkage of not more than 2 per cent.

Road oil or cutback asphalt shall be as shown on the plans for the particular projects, conforming to specifications for that grade according to the standard specifications shown below.

RAPID CURING PRODUCTS

General Requirements: The material shall be free from water and shall meet the following requirements when tested in accordance with the methods hereinafter enumerated.

Specification Designation	RC-1	RC-2	RC-3	RC-4
Flash Point (Open Tag) ° F...	80+	80+	80+	80+
Furol Viscosity at 122° F.....	80-160	200-400	.....	.....
Furol Viscosity at 140° F.....	.....	.....	275-400	700-1400
Distillation, per cent by volume:				
Total Distillate to 374° F....	5+	.....	.....	.....
Total Distillate to 437° F....	12+	10+	3+	0.5+
Total Distillate to 600° F....	25+	20+	14+	7+
Total Distillate to 680° F....	40—	35—	30—	25—
Tests on Residue from Distillation:				
Penetration 77° F. 100 g., 5 sec.	60-80	60-120	60-120	60-120
Per cent Soluble in CS_2.....	99.5+	99.5+	99.5+	99.5+
Per cent Bitumen Soluble in CCl_4	99.65+	99.65+	99.65+	99.65+

MEDIUM CURING PRODUCTS

General Requirements: The material shall be free from water and shall meet the following requirements when tested in accordance with the methods hereinafter enumerated.

Specification Designation	MC-1	MC-2	MC-3	MC-4	MC-5	MC-6
Flash Point (Open Tag) ° F.....	.....	150+	150+	150+	150+	150+
Furol Viscosity—						
At 77° F.....	40-150	.....	.....	.....	.....	.....
At 140° F.....	.....	150-250	300-500	500-800	.....	.....
At 180° F.....	.....	.....	.....	.....	170-280	300-500
Distillation, per cent by volume:						
Total Distillate—						
To 437° F.....	10—	2—	2—	1—	1—	1—
To 600° F.....	25+	10-20	8-20	16—	14—	11—
To 680° F.....	50—	27—	25—	25—	20—	15—
Tests on Residue from Distillation:						
Penetration 77° F., 100 g., 5 sec.....	70-300	100-300	100-300	100-300	100-300	100-300
Ductility at 77° F..	60+	60+	60+	60+	60+	60+
Per cent Soluble in CS_2	99.5+	99.5+	99.5+	99.5+	99.5+	99.5+
Per cent Bitumen Soluble in CCl_4..	99.65+	99.65+	99.65+	99.65+	99.65+	99.65+

SLOW CURING PRODUCTS

General Requirements: The material shall be an asphaltic base crude oil or a homogeneous residue thereof. It shall meet the following requirements when tested in accordance with the method hereinafter enumerated:

Specification Designation	SC-1	SC1-A	SC-2	SC-3	SC-4	95+
Water	.....	.....	.....	.....	.....	0.5%—
Sediment	.....	.....	.....	.....	.....	1.0%—
Water & Sediment.	2—	2—	2—	2—	2—	.....
Flash point (Cleveland Open cup) ° F. .....150+		175+	200+	200+	250+	400+
Furol Viscosity—						
At 77° F.....	20–150	.....	.....	.....	.....	.....
At 122° F.....	.....	40-100	200-300	.....	.....	.....
At 140° F.....	.....	.....	.....	150-300	350-550	.....
Viscosity Float at 122° F.	.....	.....	.....	.....	.....	225+
Soluble in CS_2 per cent	.....	.....	.....	.....	.....	99.0+
Distillation per cent by volume—						
Total Distillate—						
To 437° F.....	.....	3—	2—	2—	2—	.....
To 600° F.....	.....	25—	15—	10—	8—	.....
To 680° F.....	50—	30—	25—	20—	18—	.....
Residue of 100 Penetration @ 77° F	30-35	50-60	60-70	70-75	75-85	.....
Penetration @ 77° F., 100g., 5 sec. of residue after heating at 325° F., 50 g., 5 hr. (D6-30)	.....	.....	.....	.....	.....	125+
Tests on Residue from Distillation Float at 122° F..	50—	50—	25+	25+	25+	.....
Per cent Soluble in CS_2	99.0+	99.0+	99.0+	99.0+	99.0+	.....
Per cent of Bitumen Soluble in CCl_4	99.65+	99.65+	99.65+	99.65+	99.65+	.....

On all early work the road oil used was the "60 grade," later the "65 grade" and then the "70 grade," the first and last named grades being similar to the grades SC-2 and SC-3 as shown above. Practically all the road mix projects in the last three years have been constructed with the use of the SC-3 grade oil but during the past year several projects have been built with the use of the medium curing cutback asphalts MC-2 and MC-3 and with rapid curing cutback asphalt, RC-2, and we have reason to believe will prove entirely satisfactory and will result in decreased maintenance costs. It is the policy of the department to use the cutback asphalts on projects where the subgrades are entirely satisfactory as there may be some difficulty encountered if it is necessary that portions must be scarified and remixed. The impression in the past has been that cutback asphalts could not be successfully used in road mix work, using a dense graded aggregate but no difficulty was encountered in doing so the past season. The medium curing asphalts may be used quite as well as the slow curing product, but in the use of the rapid curing asphalt, care must be taken to have it laid down in shape as soon as possible, although it may be kept in a windrow for several hours without danger. Such mats are rolled at once upon being laid down.

Base Stabilization.—On certain projects where it is desirable to conserve the base course surfacing and at the same time furnish a good smooth and dustless surface for traffic until funds are available for the construction of a standard 2½ in. or 3 in. mat section, a special specification was provided. In many cases these surfaces are on the lighter traffic roads and no doubt will serve for many years with a minimum maintenance cost.

Bituminous Surface on Green River Highway, Rock Springs, Wyoming

Green River-Grange Highway, Wyoming

This specification provides that material needed for the bituminous surface be bladed from the base course surfacing in the amount to make a windrow of sufficient size to make a mat of 1 in. or 1½ in. in thickness as desired. After the material is bladed and placed in the windrow (scarifying is not done unless absolutely necessary as it is desirable that the surface be left in as smooth a condition as possible) the base is then treated with a prime coat of MC-1 cutback asphalt, using from 0.30 to 0.50 gal. per square yard as required. After the prime coat has set up, or generally after 24 hours, the windrow is spread and oil applied with a pressure distributor, using from 0.75 to 1.00 gal. per square yard of MC-2 or MC-3 cutback asphalt. The material is then thoroughly mixed and laid down as with the regular road mix process. It is then rolled and seal coated.

This method for thin treatments has been in use by the highway department for a number of years, though formerly SC-2 and SC-3 grade oils were used instead of the medium curing cutbacks. MC-1 as a base treatment and RC-2 for the top course has also been used with success.

Where it is undesirable to disturb or use any of the base course surfacing, enough material is added to produce the thickness of mat desired.

Seal Coat.—All surfaces receive a seal coat, immediately after construction or as soon as the oil mat has received satisfactory compaction. On most of the projects where the SC oils are used, the amount necessary is approximately ⅛ gal. per square yard. On mats constructed with the use of MC or RC cutback asphalts the amount required is approximately 0.20 gal. and in some cases may be increased to 0.25 gal. RC-1 cutback has been used mainly for this purpose but RC-2 proves more satisfactory on the rougher or more open surfaces.

This treatment generally lasts for two or three years when it must be renewed.

Formerly it was the intention to get enough oil or cutback in the mats so they would naturally seal themselves. This proved difficult as it generally led to the use of too much oil in the mat, making it unstable with a tendency to roll and corrugate. It has been found to be more satisfactory to provide a somewhat leaner mix, making the mat more stable, and then place a seal coat for the protection of the surface and exclude any moisture.

Stone Chips Seal Coat.—This treatment is placed on bituminous surfaces where the mats themselves have proven to be in good shape, to provide a more no-skid surface and make the roads more safer for night driving, it producing a lighter colored surface that does not absorb the light rays as does the black asphaltic surface.

RC-2 cutback asphalt is applied to the surface at the rate of approximately 0.25 gal. per square yard, immediately covered with stone chips, 18 to 20 lb. to the square yard and rolled lightly at once. Stone chips must all pass a ⅝ in. screen and be retained on a ⅛ in. screen. This process has proven very satisfactory and has caused a great deal of favorable comment from the traveling public.

Conclusions.—This article has dealt almost entirely with the road mix type of bituminous surface but when it is known that the amount of concrete pavement on the Wyoming State Highway system amounts to only approximately 35 miles, it may be seen that this department is mostly concerned with the lower cost types of road surfaces. They have proven themselves in this state and no doubt will continue to be constructed as long as they satisfy the demands of traffic. Only by their construction could the highway system of the state have been brought to its present standard. The amount of money spent for oiled roads in Wyoming, if spent for hard surface, high type roads would not have gone very far. With improvements inconstruction of subgrades, more knowledge being gained of the proper use and kind of materials to be used, it is believed that this type of road will continue to be built and prove satisfactory for the demands of traffic for many years to come, and no doubt will pay for themselves many times before having to be replaced.

▼

Shovel with Special Snow Dipper

The equipment pictured below was a big help in cleaning up the heavy drifts which hampered traffic in southern Wisconsin last month. When successive storms brought a condition which could not be met with the snow clearing equipment on hand, shovels and other emergency units were rushed out.

In the beginning the shovels were taken simply as they were, there being no time to wait for the manufacture of oversize dippers to increase the output. Before the emergency was past, however, a special 3-yard dipper was completed and attached to a ¾-yard Koehring shovel as here shown, with a proportionate increase in the rate of clearing. The shovels were found to be particularly valuable where drifts were deep and the snow packed or frozen. Both county-owned equipment and equipment rented from contractors were used.

Three-Fourths Yard Shovel Equipped with Three-Yard Special Dipper Clearing Pavement in Milwaukee County, February, 1936.

View at Prospect Park, W. Brooklyn. Track Structure Ready for Receiving Concrete Pavement. Notice Steel Fabric Reinforcement Below Track Assembly. A Similar Layer of Reinforcement Was Placed 2 In. from the Surface. Transverse Expansion Joints 25 Ft. Apart. Anchor Bars 2 Ft. Apart Through Rail Web.

CONCRETE CAR TRACK PAVING IN NEW YORK CITY

THE Brooklyn and Queens Transit Corporation, New York, N. Y., operating the surface track lines of the B. M. T. system, undertook in 1933 the first concrete track paving on its lines and during the period 1933-35 completed 13 miles of this type of track structure.

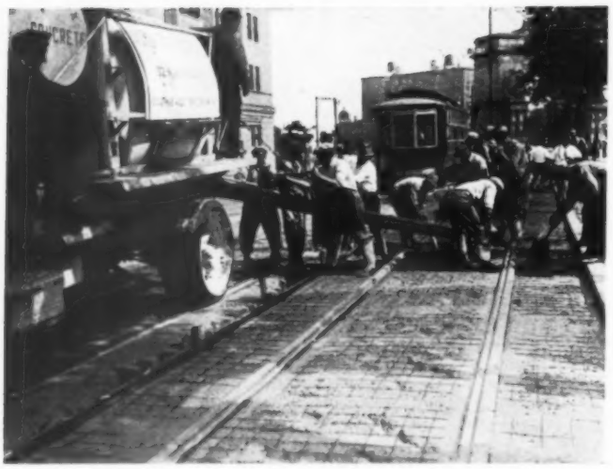
Track Integral Part of Concrete Roadbed.—The design developed provides for a structure in which the track is made an integral part of the concrete roadbed, and one which eliminates the wooden ties previously used. An important economy is effected by the use of 4½-in. grooved girder, 105 lb. rails instead of the 7-in. rails in use before.

The Track Assembly.—The track assembly on the lines in Brooklyn and Queens involves the use of 2 by 2½-in. angle cross ties, 6 ft. long, spaced 4 ft. apart which are bolted to the grooved girder rails, and ¾-in. anchor bars which are inserted through holes in the web of the rails at intervals of 2 ft. The assembly is supported at finished grade on blocks and the concrete is made to flow underneath and around the various parts of the track structure. Steel fabric reinforcement, cut in convenient lengths for easy handling, is placed beneath the track in the bottom portion of the concrete slab and also 2 in. from the surface. One new experimental section recently completed involves the use of "dummy" joints for crack control, installed above every other cross-tie, or at 8-ft. intervals. Transverse expansion joints, usually placed at 25-ft. intervals, and also reinforcement, are omitted on this section. The results give much promise.

Paving on 86th St., Brooklyn. A Plane Surface Is Used for the Pavement Cross Section; ¼ In. Preformed Joint Filler is Used at Intervals of 25 Ft. with Plain Butt Joint in Center of Devil Strip.

Pavement Is of 2-Course Construction, the Upper 2 In. Being Colored by Use of Emulsified Carbon Black. Track Pulsator Shown in Position on Rails. Concrete Truck Mixers in Left Roadway.

Vibration Method Employed.—Specifications for all work called for ready mixed concrete delivered from commercial truck mixers and placed by the vibration method, using track pulsators. The pulsator consolidates the concrete around the rails and reinforcement, tying the structure into a rigid unit. Standard methods of controlling the concrete are employed to include selection of aggregates, water control and time of mixing. The proportions are approximately 1:2:4 based on a water cement ratio of 6 gallons of water per bag of



Notice Difference in Color Between Base Course and Wearing Course Concrete. Emulsified Carbon Black Was Added at Rate of 2 Lb. Per Bag of Cement.

cement and an expected strength of 3,000 lb. per square inch at 28 days.

Construction Methods.—The work of building a new track structure on any heavily traveled street is undertaken with consideration for both rail and motor traffic. It was determined that the construction could be carried out most efficiently when divided into sections approximately 1,200 ft. in length. And to avoid undue interference with service to the public, the sections placed under construction are staggered so that it is unnecessary to operate under single track restrictions in both directions for more than 1,200 ft. in any one location.

Concrete is deposited directly from truck mixers on the prepared assembly. After preliminary spreading by hand it is thoroughly consolidated by the pulsator. This device consists of a vibrating machine driven by a motor and the whole mounted on a standard gauge four-wheel steel car. During the vibrating of any section the pulsator is securely clamped to the rails so that the vibrations are transmitted to the entire assembly and thence to the concrete. The pulsator also performs the striking-off operation to bring the concrete surface to the proper level. The final finishing follows the procedure usually to be observed on regular concrete street pavements. The last operation consists of brooming the surface to provide uniform texture. The concrete is then cured by the use of hay and water or by other approved method.

New "Black Concrete" Track Pavement on Left, Old Pavement on Right. Truck Mixers on Right Hauling Concrete to Job.

The projects were built under the supervision of H. J. Kolb, Chief Engineer, and Chas. W. Burke, Assistant Chief Engineer, Way and Structure Department, Brooklyn and Queens Transit Corporation, New York City.

New Traffic Line Uses Crushed Porcelain

A traffic strip consisting of porcelain chips glued to the pavement with a special bitumen has been invented by a Danish Engineer, Karlo Nielsen, Martensens Alle 8 Copenhagen, Denmark.

Waste porcelain crushed to a size of 3/32 to 5/16 in. is used. The bitumen is ordinary hard bitumen, fluxed with a light flux which rapidly vaporizes, leaving the hard bitumen as a binder between the road surface and the porcelain chips. The most important advantage of the porcelain stripe is said to be its reflective power at night.

Top: Traffic Striping Outfit at Work on a Road. Middle: Closeup of the Machine Showing Asphalt Pot, Porcelain Bin and Roller. Bottom: Traffic Lines at Road Intersection

A GLOSSARY OF GEOLOGICAL TERMS FOR THE HIGHWAY ENGINEER

By D. G. RUNNER
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THERE are now available several glossaries of terms suitable for use in highway engineering. One of these may be found in the 1935 Powers Road and Street Catalog and Data Book. Another such list of highway terms has been provided by The Asphalt Institute in their Manual Number 2, entitled "Asphalt Road Construction." These glossaries are chiefly applicable to the defining and explaining of terms dealing with road construction in its various fields. It was thought that a set of explanatory terms relating more to the geologic phase of materials as applied to road buiding should be of interest to the highway engineer. Accordingly the following definitions are presented towards this end. The numbers in parenthesis after the terms refer to the source of the reference or to literature where discussion of the subject matter may be found.

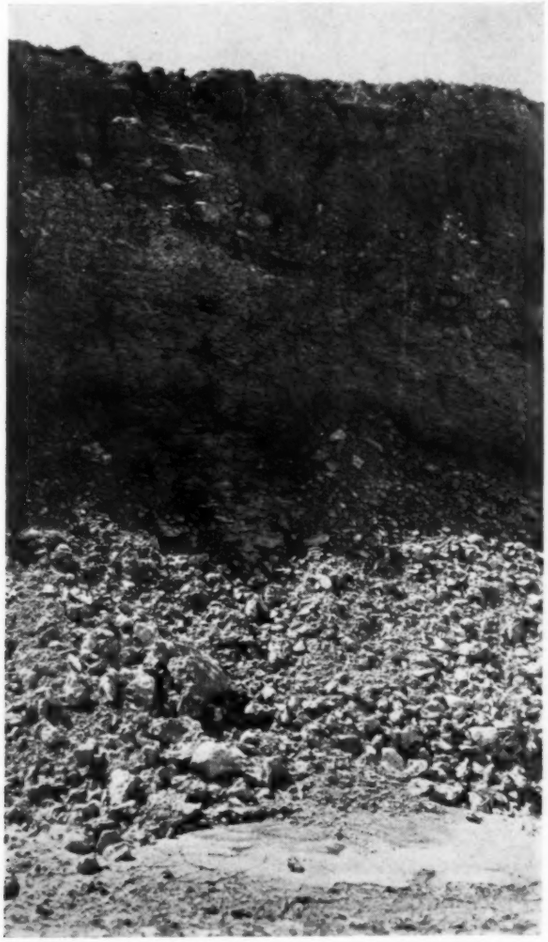

Fig. 1—A Deposit of "Hard" Caliche, Texas. (Photograph by Courtesy of Texas Highway Department.)

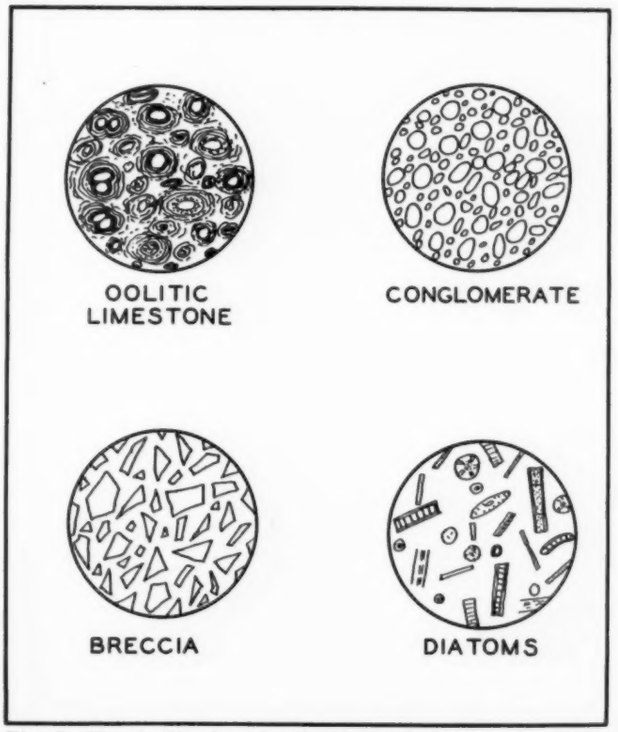

Fig. 2—Sketch Showing the Structure of Oolitic Limestone, Conglomerate, Breccia, and Diatoms Which Form "Diatomaceous Earth."

Aggregate—The inert material, such as sand, gravel, shell slag or broken stone or combinations thereof, with which the cementing material is mixed to form a mortar or concrete. (1)

Alluvium—Deposits of mud and silt commonly found on the flat lands along the lower courses of streams.

Arenaceous—From the Latin word "arena" meaning sand. Like, or pertaining to sand. An example is arenaceous limestone, or a sandy limestone. (2)

Argillaceous—Containing or consisting of clay. An example is argillaceous limestone, meaning one containing a high percentage of clay. (2)

Ashes (Volcanic)—Fragments of lava and pieces of rock driven upwards by violent expansion and expulsion. The material usually hardens in its passage and falls in solid form. According to size, those particles the size of peas are volcanic ashes. (3)

Bank Gravel—Gravel found in natural deposits, usually more or less intermixed with fine material, such as sand or clay, or combinations thereof; gravelly clay, gravelly sand, clayey gravel and sandy gravel, indicate the varying proportions of the materials in the mixture. (1)

Basalt—Any volcanic rock of micro-crystalline or amorphous texture, dark color and high true specific gravity, indicating porous or volcanic basalt which by reason of its structure has a low apparent specific gravity. (1)

Bed (of Rock)—A single layer or stratum of rock, which may be either an inch or a hundred feet or more in thickness.

Bedding Plane (of Rock)—Refers to the plane of junction between different beds or layers of rock. (4)

Bentonite—The plastic residue from the weathering of ash

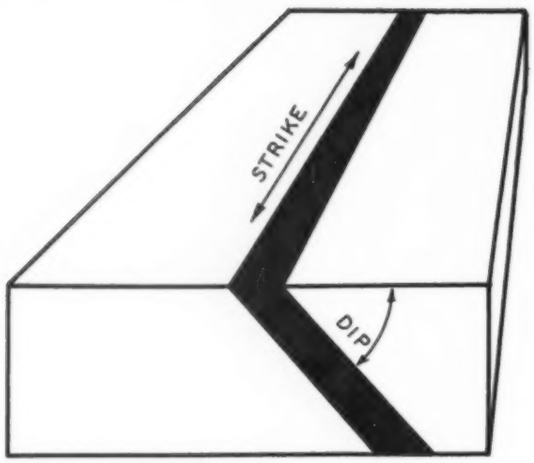

Fig. 3—Block Diagram Illustrating the Dip and Strike of a Stratum.

(volcanic); it swells enormously in water and forms a milky suspension. (5)

Boulders—Detrital material greater than 200 mm. or about 8 in., in diameter. (4)

Caliche—A material found chiefly in the southwestern part of the United States. It is composed essentially of soft limestone with varying percentages of clay. Figure 1 shows an outcrop of caliche in Texas. (6)

Chats—The gangue material which is found intimately mixed with the lead-zinc ores of Missouri and Oklahoma. It is closely akin to chert and is the by-product of metal mining.

Chert—A very fine-grained dense rock consisting of opal or chalcedony, often with some quartz, and sometimes with accessory calcite, iron oxide, organic matter, sponge spicules, or other impurities. It is usually associated with limestones, either as entire beds or as isolated included masses. It has a homogeneous texture, and a white, gray, or black color. (7)

Clay—A fine argillaceous material which is more or less plastic when wet. The most important constituent of clay is hydrous aluminum silicate gel, a colloidal material, which remains suspended indefinitely in water, but may be thrown down as coagulated matter by salt solutions. When dry, clay is a fine, earthy material having a characteristic odor when moistened by the breath. It clings to the tongue, and makes a smooth paste when rubbed to an incoherent mass between the fingers. When pure, clay is white, but it is commonly colored yellow, brown, or red by iron oxides, or gray, blue, or black by organic substances. The grain size of clay is commonly considered as minus 0.005 mm. (8)

Cleavage—Is that capacity of certain rocks to part along parallel planes. It may be original in beds or secondary in metamorphic rocks. (9)

Coquina—Consists essentially of marine shells which are held together by a little calcium carbonate cement so as to form a fairly firm rock. It is full of cavities but is strong enough for use in building operations. The classic example is the "coquina" of the east coast of Florida.

Crusher-Run—Refers to the product of the crushing plant without being rescreened or separated into various sizes.

Diatomaceous Earth—Is composed essentially of the siliceous skeletons of diatoms, extremely minute uni-celled organisms. It is composed mainly of silica, white or light gray in color, and is extremely porous. See Fig. 2.

Dip (of Rock)—Is the angle of inclination of the plane of stratification with the horizontal plane. See Fig. 3.

Dolomite—A magnesian limestone, composed essentially of the mineral dolomite, a double carbonate of calcium and magnesium. It is theoretically composed of 54 per cent calcium carbonate and 46 per cent magnesium carbonate. (1)

Faults—May be considered an an abrupt break in the continuity of the beds or strata with the elevation or depression of beds on one side of the plane of the fault. See Fig. 4. (10)

Field Stone—Loose rock commonly of assorted sizes and character found upon the surface of the ground. Such material is usually associated with nearby outcrops of rock. See Fig. 5.

Flint—A sedimentary rock, dark gray to black in color, hard, dense, composed essentially of minutely-crystalline silica with little chemically combined water. Flint is commonly found in chalk beds.

Gilsonite—A hard, brittle, native asphalt occurring in various localities in rock crevices or veins from which it is mined like coal. (11)

Gneiss—A medium or coarse-grained crystalline rock possessing some form of parallel structure due either to the uniform orientation of certain tabular or prismatic minerals, or to the presence of wavy discontinuous surfaces indicating a lenticular structure, or of bands of varying mineralogical composition which retain their continuity and parallelism throughout a considerable mass of rock. Some examples are banded gneiss, granite gneiss, etc. (12)

Grain (of Rock)—Refers to the direction of splitting at right angles to the "rift." See Fig. 6.

Granites—Are crystalline, even-grained rocks consisting essentially of feldspar and quartz with smaller amounts of mica and other ferro-magnesian minerals. (13)

Gravel—The granular, pebbly material (usually coarser than ¼ in. in diameter) resulting from the natural disintegration of rock. The rounded character of some gravel particles has been imparted by stream action.

Grit—A coarse sand formed mostly of angular quartz grains. (14)

Gumbo—The natural soil found in certain parts of the middle west, notably Minnesota, the Dakotas, Missouri and Iowa, which are finely divided clays of varying capillarity. (15)

Ingenous Rocks—Are those which have been formed or crystallized from molten magmas, the source of which has been the earth's interior. Examples of this type are granites, syenites, gabbros, etc. (13)

Indurated—Refers to rocks that have been hardened by heat. Occasionally the term is applied also to sediments hardened by impregnating solutions. (2)

Joints—Traverse the rocks in different directions and at various angles, and in most areas there are at least two systems. The spacing of joints may vary greatly, sometimes being measured in inches, at other times in yards. Joints are a matter of practical importance as the system and extent of this feature governs the size of the stone that can be removed from the quarry. See Fig. 7. (3)

Kaolin—A white non-plastic material, consisting in the raw state, of the mineral kaolinite (pure hydrated silicate of alumina) mingled with fragments of quartz, feldspar, mica, the residual minerals of granite. (4)

Laminations—Refer to the banding in rocks caused by variations in color of different minerals. Quite often these laminations result in the rock breaking easily along the laminated portion. This feature is exemplified in the gneisses.

Lime Rock—A natural material found chiefly in Florida and

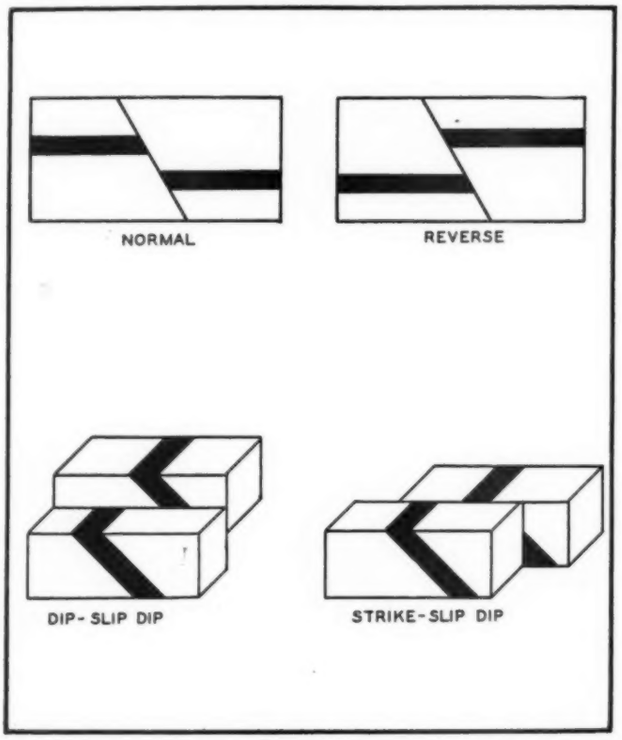

Fig. 4—Diagram Showing Four Types of Faults. (After Lahee.)

Fig. 5—A Deposit of Field Stone.

Georgia. It is composed essentially of calcium carbonate with varying percentages of silica. Lime Rock hardens upon exposure to the elements and some varieties provide excellent road metal. See Fig. 8. (16)

Limestone—Any natural rock of sedimentary origin composed principally of calcium carbonate or of calcium and magnesium carbonates in either its original chemical or fragmental, or recrystallized form. (1)

Loess—Is wind blown silt or silty clay having little or no stratification. Some of its peculiarities are the light color, fine state of subdivision, the sharpness and angularity of its particles, its porosity and coherence.

Marble—Any crystalline or micro-crystalline natural rock deposit of sedimentary origin composed principally of calcium carbonate or calcium and magnesium carbonates. This classification includes also those serpentines that are of igneous origin as well as those of sedimentary origin. (1)

Marl—An earthy mixture of minerals consisting of quartz, clay, calcite, and sometimes glauconitic sands. It is quite often found in swamps and in lakes.

Metamorphic Rocks—Those rocks which have been changed by temperature, pressure, and chemical fluids into new forms being more stable under the new conditions. Some examples are, gneisses, schists, marbles, etc. (12)

Oolitic Limestone—Those limestones consisting largely of minute spherical or ellipsoidal grains of calcium carbonate which resemble fish roe. See Fig. 2. (4)

Outcrop (of Rock)—Those places where the underlying bedrock comes to the surface of the ground and is exposed to view. See Fig. 9.

Overburden—Refers to the soil mantle, waste material, or other similar matter found directly above the deposit of rock or sand-gravel. The amount of this overburden has a direct economic effect upon the amount of material capable of being produced.

Pebbles—Rock fragments of small or moderate size which have been more or less rounded by erosional processes. (17)

Quartzite—A dense sandstone rock which has been thoroughly cemented by silica or which has been indurated or hardened by a recrystallization process.

Quartz—Is composed entirely of silica (SiO_2) is colorless when pure, but often tinted yellow, red, blue, violet. It has a specific gravity of 2.65, and is the most common mineral in sand.

Red-Dog—Is the residue from burned coal dumps. The dumps are composed of waste products incidental to coal mining, which are not true coal but contain a certain percentage of carbon. Under pressure in the waste dumps, they frequently ignite from spontaneous combustion and the residue is a red-colored ash containing a high percentage of silica with certain mineral salts distributed throughout the mass, which when wetted will form a firm and hard surface. (15)

Rift (of Rock)—Quarrymen usually refer to the direction of easiest splitting as the "rift." See Fig. 6, and compare with "grain" and the "hardway."

Rock Asphalt—A porous rock which has become naturally more or less impregnated with asphalt or maltha. Some examples are, Kentucky rock asphalt, and the Uvalde rock asphalt of Texas. (11)

Rubble—Rough stones of irregular shapes and sizes, broken from larger masses either naturally or artificially, as by geological action, in quarrying, or in stone cutting or blasting. (1)

Sand—The fine granular material (usually less than ¼ in. in diameter) resulting from the natural disintegration of rock, or from the crushing of friable sandstone rocks. (1)

Sand-Clay (Road Surfce)—A surface composed of a mixture of sand and clay where the two materials have been blended, so that their opposite qualities tend to maintain a condition of stability under varying moisture content. Some deposits are found in nature, but the bulk of such surfaces are prepared artificially. (15)

Sandstone—A typical sandstone is composed essentially of rounded grains of quartz, with or without interstitial cementing material, with the larger grains tending to be more perfectly rounded than the smaller ones. The fracture in sandstones takes place usually in the cement, leaving the grains outstanding, thus giving the rock the appearance and feeling of loaf sugar.

Screenings—Broken rock, including the dust, of a size that will pass through one-half to a three-quarter inch screen, depending upon the character of the stone. (18)

Scoria—Is applied to lava in which the gas cavities are numerous and irregular in shape. The escape of the glass distends the molten material which produces the cavities. (4)

Schists—Differ from gneisses in being of finer grain, and in possessing a well-marked tendency to split into thin layers, except when puckered or folded by movement subsequent to the development of schistosity. Some examples of schists are, mica schist, sericite schist, etc. (12)

Sedimentary Rocks—Are formed by the decay of existing strata with subsequent deposition of the solid material that has been carried in suspension by agencies of transportation to some point where they have been redeposited. (19)

Serpentine—Refers to soft greenish-colored rocks composed essentially of the mineral serpentine, or hydrous silicate of magnesia. (10)

Shale—A material composed essentially of silica and alumina, which has, in addition a more or less thinly laminated structure. This structure has been imparted by the natural stratification of extremely fine sediments together with more or less pressure. (20)

Shell—The term is applied to oyster or clam shells which have been dredged from the seas and used for a road surfacing material.

Silt—Consists of the finer particles of rock substance and ranges in size from 0.05 to 0.005 mm.

Slates—Are rocks, normally clayey in composition, in which pressure has produced a very perfect cleavage, so that a block of slate can be readily split into thin, smooth, tough plates. (10)

Soapstone—Are rocks which usually consist of the mineral talc or some closely related mineral species. Talc is a hydrous magnesian silicate theoretically composed of 63 per cent silica, 32 per cent magnesia, and 5 per cent of combined water. (10)

Soil—A mixture of fine earthy material with more or less organic matter resulting from the growth and decomposition of vegetation or animal matter. (1)

Spall—A small piece or fragment broken from a larger piece of rock.

Stone—Any natural rock deposit or formation of igneous, sedimentary and/or metamorphic origin, either in its original or altered form. (1)

Stone-Sand—Refers to the product (usualy less than ¼ in. in diameter) produced by the crushing of rock. This material

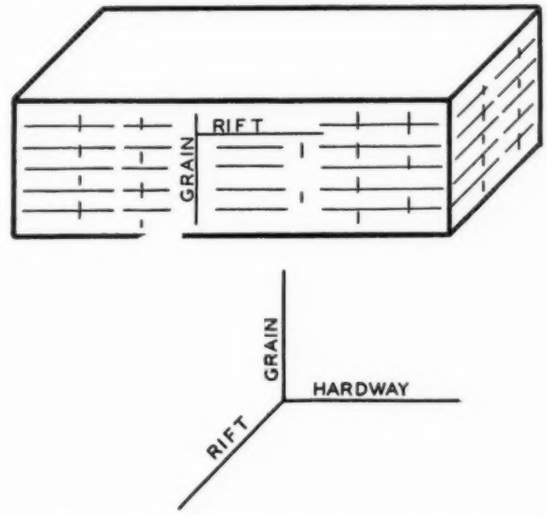

Fig. 6—Sketch Illustrating the Structures of Rock Which Are Closely Associated with Jointing. The "Rift" Is the Easiest Way of Splitting, and the "Grain" Is Usually at Right Angles to the Rift. The "Hardway," or Head Grain, Is the Direction at Right Angles to Both the Rift and Grain.

Fig. 7—An Outcrop of Rock Showing Vertical and Horizontal Jointing.

is usually highly processed, and should not be confused with screenings.

Strike (of Rock)—Is the direction of the line of intersection of the plane of stratification with the horizontal plane. See Fig. 3. (3)

Sub-Grade—The upper surface of the native foundation on which is placed the road metal or artificial foundation, in case the latter is provided. (18)

Sub-Soil—The bed of earth immediately beneath the surface soil. (18)

Stratification (of Rock)—Is indicated by differences in composition, texture, hardness, cohesion and/or color of the rock disposed in parallel bands. See Fig. 9. (4)

Tailings—Stones which after going through the crusher, do not pass through the largest openings of the screen. (1)

Talus—A term used for the accumulation of fine, coarse, or mixed fragments and particles, fallen at or near the base of cliffs. See Fig. 10. (21)

Texture (of Rock)—Is applied to the microscopic features, including the forms of crystals and the manner in which they are united. (2)

Top-Soil (Road Surface)—A variety of surfacing used principally in the southeastern states, being the stripping of certain top-soils which contain a natural sand-clay mixture. When placed on a road surface, wetted and puddled under traffic it develops considerable stability. (15)

Trap—Includes the dark-colored, fine-grained and dense igneous rocks composed essentially of the ferro-magnesian minerals, basic feldspars, and little or no quartz. The ordinary commercial variety of trap is basalt, diabase, or gabbro.

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Fig. 8—An Outcrop of Ocala Lime Rock in Florida.

Fig. 9—An Outcropping of Limestone Showing a Sharp Angle of Dip and Extreme Stratification.

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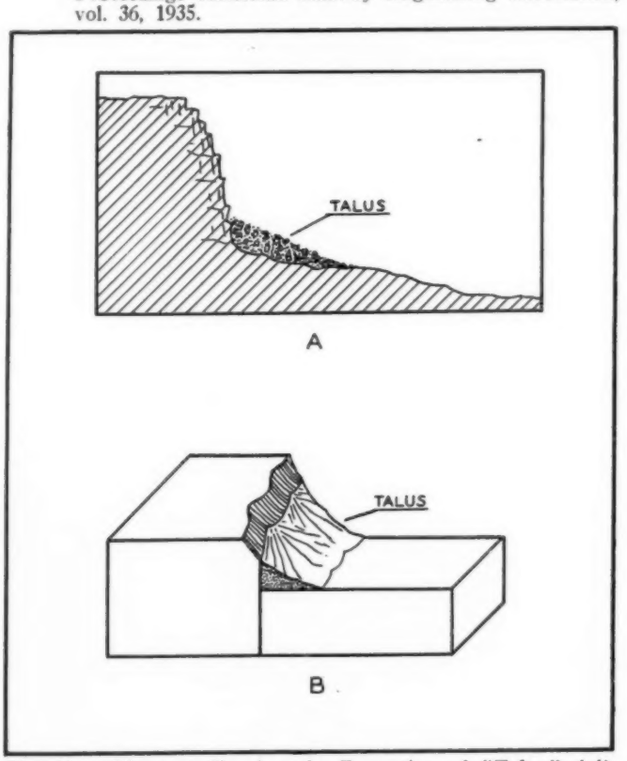


Fig. 10— Diagram Showing the Formation of "Talus." (A) From a Cliff, and (B) from a Fault Scarp. (After Lahee.)

DRAINING WET SUBGRADES UNDER EXISTING PAVEMENTS

By BEN H. PETTY

Professor of Highway Engineering
Purdue University

BADLY cracked and settled pavements caused by soft spots in the subgrade resulting from excessive accumulation of water unable to find a drainage outlet presents one of the most serious problems with which highway maintenance engineers are faced. These soft spots usually occur near the top of grades and during certain seasons of the year, water frequently flows out through cracks onto the surface of the pavement, sometimes resulting in dangerous ice films during the winter season. The pounding of heavy trucks continues to break up the pavement slab over these soft subgrades necessitating costly maintenance operations.

This is especially true with the low-cost black top types where a stable subgrade is necessary to support the thin crusted wearing surfaces. This type of surface frequently breaks up in the winter or early spring over these soft spots and in addition to being a menace to traffic also calls for expensive maintenance operations. Naturally, similar break-ups occur on gravel or stone roads under similar subgrade conditions.

Obviously the problem should have been solved before the road surfacing materials were placed on the subgrade. Proper investigations of subsoil conditions prior to paving would have indicated the probable need of some type of sub-drainage at these particular spots. The source of the water causing this trouble should have been ascertained and "blind drains" or pipe drains should have been installed so as to properly intercept this water and carry it out to the side ditch or other points of discharge. This would prevent ponding and the resulting saturation of the subgrade soil which destroys its supporting value.

In highway departments where an organization has not been set up for subgrade study, it is the writer's contention that the probable needs of subgrade drainage nevertheless can be anticipated accurately enough to

Fig. 2—Installation of an 8-Inch Perforated Metal Pipe Under the Missouri Pacific Railroad Tracks in Tuxedo Park, St. Louis, Mo.

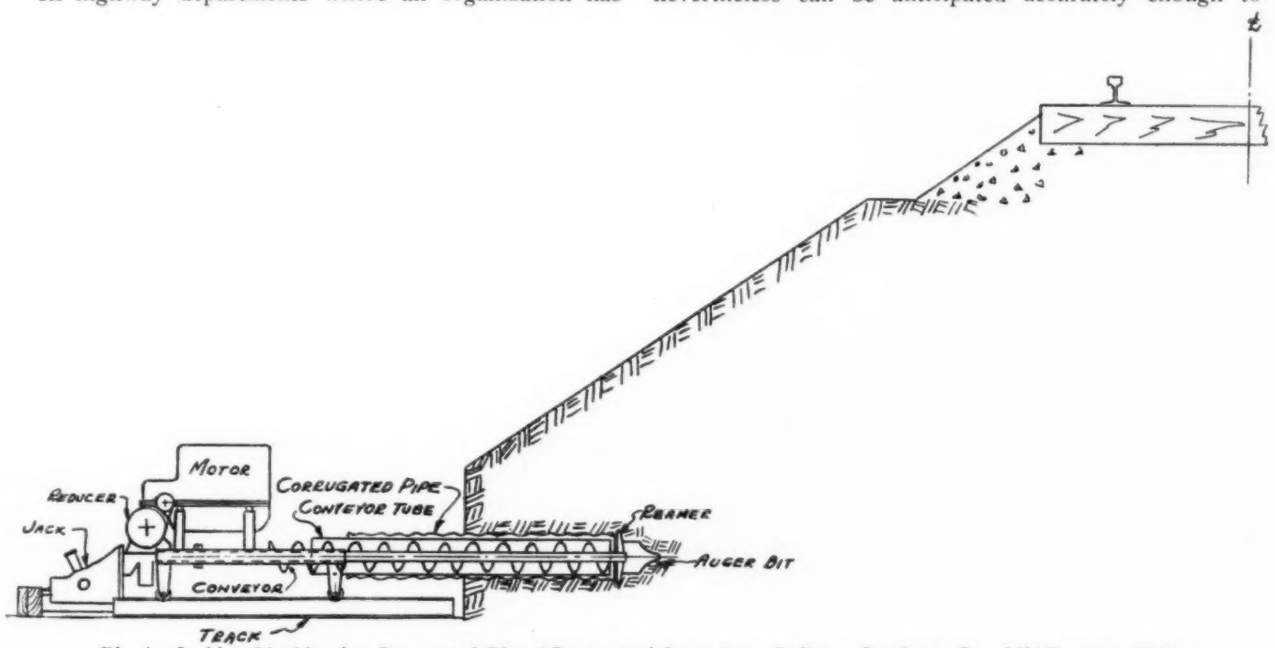


Fig. 1—Jacking Machine for Corrugated Pipe (Courtesy of Ingot Iron Railway Products Co., Middletown, Ohio)

Fig. 3—Another View Showing Installation of 8-Inch Perforated Metal Pipe Under the Missouri Pacific Railroad Tracks in St. Louis. This Clearly Illustrates Non-Interference with Traffic.

eliminate most of the trouble. In a state like Indiana, for instance, we are practically sure that soft spots are going to develop in subgrades near the tops of grades at some time during the winter or early spring and that the sources of trouble can quite probably be corrected through the proper installation of, for instance, a herringbone system of trenches, backfilled with porous material, or with pipe installations, leading from the center line out to the side ditches. The cost of such installations would be much less, in the long run, than the accumulated total of repair bills necessitated by the annual break-up of road surfaces, over these neglected sections.

Fig. 4—An Attempted Installation of a Corrugated Metal Conduit for a Water Pipe Under a Paved Highway Which Was Balked at This Particular Point, Due to Encountering Too Much Rock in the Subgrade Fill.

Unfortunately, there are thousands of miles of surfaced highways already constructed, on which no attention whatever was given to subgrade drainage prior to surfacing. With the lower type surfaces, these subgrade installations could be made at any time and the necessary surface cuts repaired at a reasonable cost. In the case of high type pavements, however, it would seem to be of doubtful economy to cut through the pavements at frequent intervals for the installation of subdrains over bad subgrade sections.

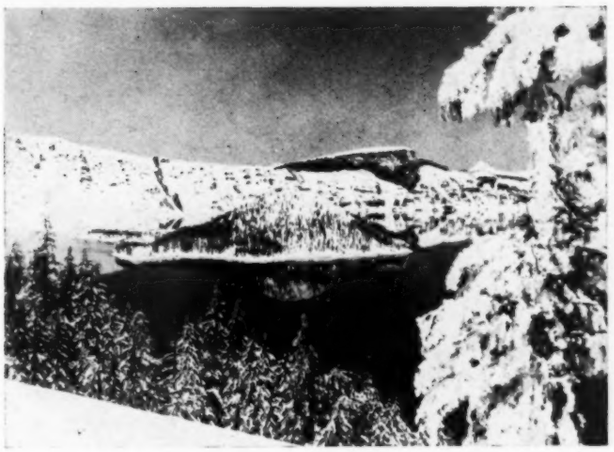
Our brethren in the railway engineering profession have already set us a good example in draining wet fills and subgrades through the installation of perforated pipe by the jacking method after the trouble has developed. Figure 1 illustrates the set-up of a jacking machine for the insertion of perforated corrugated pipe into a wet railway fill. Figures 2 and 3 are actual views of such installations.

It has occurred to the writer that some such method as this could be profitably used by the highway engineer

Fig. 5—A View Illustrating the General Set-Up in Jacking a Perforated Metal Pipe Under a Pavement to Drain a Wet Subgrade

in correcting bad subgrade conditions after pavements have been constructed in order to eliminate further pavement destruction with the resulting high maintenance costs. Possibly this practice is already common in certain localities but if so, the writer has never heard of it. Figures 4 and 5 illustrate possibilities of using this method under highway pavements. We have no reliable figures on the cost of such work but are of the opinion that in general it would be cheaper than tearing out the pavement slabs, digging the necessary trenches, backfilling with porous materials or using pipe installations, and then repaving over these particular sections.

This article has been prepared with the hope that it may stir up some discussion of this proposed method of handling one of our serious highway maintenance problems and with the thought that it may stimulate engineers who have actually used this method to submit manuscripts for publication, explaining such operations, and giving costs, for the benefit of highway engineers in general. One wonders if we are justified in applying the term *engineer* to a highway man who persists in spending road funds year after year in repairs rather than to correct the defect which causes this annual damage.



Crater Lake Just After a Winter Storm. Wizard Island, a Volcanic Cone, Is in the Foreground, with Llao Rock in the Background

SNOW REMOVAL THAT IS SNOW REMOVAL

HANDLING 12 TO 18 FT. OF SNOW AND 30 FT. DRIFTS AT CRATER LAKE NATIONAL PARK

By E. A. ROSTEL

Crater Lake National Park, Crater Lake, Ore.

LOCATED in one of the most severe storm areas on the Pacific Coast, Crater Lake National Park on the crest of the Cascade mountain range offers more than ordinary problems in snow removal to maintain open roads to this southern Oregon scenic wonder. Snow is deep in this region over six months of each year, averaging from 12 to 18 ft. on the level and as deep as 80 ft. in drifts.

In past years the park was completely isolated during the winter months due to closed roads which were not opened to travel until late spring and sometimes not until July when snow removal depended principally on hand labor and the use of large amounts of powder to loosen the frozen white which had been undisturbed throughout the long winter.

Park Kept Open Entire Year.—Several pieces of snow removal equipment were tried before the present high-powered rotary plow was found to be the most

A General View of the Crater Lake Headquarters Area in March. The Rotary Plow on the Left and the Bulldozer on the Right Were Used to Break Open the Road After the Snow Had Lain Undisturbed Throughout the Length of the Winter.

A Snow Plow at the Lodge in the Rim Area of Crater Lake National Park, Showing the Immense Amount of Snow Removed to Keep This Portion of the Park Roads Open Late in Spring.

efficient in tearing through the white depths. During the current winter of 1935-36, the park is being kept open for the first time for the entire year to offer the motoring public easy access to the park and view the blue waters of Crater Lake surrounded by precipitous crater walls which were once a part of one of the largest volcanoes on the continent until approximately 7,000 ft. of its summit was destroyed in prehistoric times. The lake, 2,000 ft. deep, is resting in the crater of the extinct volcano.

The first severe storms of the season arrive in October leaving from 1 ft. to 2 ft. of snow on the ground, with a general average of 3 ft. for the month, followed by approximately the same amount for November and a much heavier fall in December.

Storms of Two Weeks' Duration.—During severe winter storms, it is necessary to operate the plow in 24-hour shifts to keep up with the swirling flakes which sometimes have left as much as 36 in. during a 24-hour period. To add to the difficulty of keeping 25 miles of park roads free of snow, strong winds often blow the cuts closed when snow is dry and powdery, resulting in considerable duplicate efforts. In the evening, the road may be open but the next morning sections of it may be entirely closed.

It is not uncommon for storms to continue two weeks without cessation, with snow falling so fast at times it becomes so deep on the highway as to make it impossible for trucks to bring gasoline to the plow while at work. It is necessary for the plow to dig its own way back to the source of supply.

Snow Cuts at Annie Spring in Crater Lake National Park. A Snow Tunnel Leads to the Checking Station Building Where Many Thousands of Visitors Register in Summer Time.

The Plow Working in Snow Over 15 Ft. Deep Clearing Its Way Through Depths Covering the Utility Area in Crater Lake National Park. The White Geyser of Snow Is Arching Into the Sky for 40 to 50 Ft.

Deep Cuts Present Problems.—As the winter progresses, snow cuts become gradually deeper until the park road resembles a snow canyon with banks from 15 to 20 ft. high on either side. These deep cuts bring problems in the form of overhangs or snow protruding beyond the edge of the main cut. They are too high to be removed by the snow plow and must be knocked off by tiring hand labor, taking considerable time and patience.

Snowfall continues heavy during January and February, followed by substantial falls in March and April and even in May. In 1933 over 8 ft. fell during the month of May. Thawing is well under way in June and practically over in July, although in some summers snow never melts in shaded spots.

Frozen Drifts Cut Through With Bulldozers.—En-

Men with Shovels Removing Overhangs from the Park Highway, So Deeply Banked with Snow That the Snow Plow Is Unable to Remove the Protruding Snow Which Sometimes Extends Over 6 Ft. Into the Main Road Forming Miniature Snow Caverns Along the Sides of the Cut. The Overhangs Have Extended So Far Into the 16-Ft. Wide Road That There Was Not Sufficient Room for the Snow Plow to Pass By.

circling the lake for a distance of 35 miles, the Rim Road, the only drive of its kind in the world, presents snow removal problems later in the season. Snow on this route remains untouched until June and by that time has become so hard packed, considerable difficult is experienced in cutting through deep drifts formed during the winter. The deepest and largest drift is located at the base of "The Watchman," first high point on the west rim. During the height of the winter, the drift is as deep as 80 ft. and is still 30 ft. when snow plows begin their work.

Having the consistency of ice, it is impossible to use the regular rotary plow alone, necessitating the aid of bulldozers or blades to cut through the frozen drifts. Over four weeks' steady plowing are necessary to open the road which is usually ready for traffic during June, providing motorists with the novelty of driving between snow banks from 20 to 30 ft. high. In opening the drift, the bulldozer breaks the snow sufficiently into small blocks so as to be handled by the rotary plow, a distinct improvement over old methods.

The use of modern equipment brings about the opening of the rim road much earlier than in past years. Before the installation of the new equipment, it was opened as late as August. One year it was not opened until the last week in August and a week later a heavy snow storm arrived and closed the road for the season.

The maintenance of open roads to Crater Lake during the winter is resulting in the arrival of hundreds of motorists from Oregon, as well as out-of-state visitors, to view the southern Oregon scenic wonder in its white raiment. Scores of parties have arrived to indulge in winter sports now in the course of development in the Crater Lake area, ideal for this form of recreation in view of the consistently deep snow, still present when it has long disappeared in the lower altitudes.

The park elevation ranges from 5,000 to almost 9,000 ft., with 7,000 ft. the prevailing elevation in the Rim area of the park.

MEXICO TO SPEND $12,880,000 FOR HIGHWAY CONSTRUCTION.—The Mexican Government has allotted $9,800,000 for highway construction in 1936. In addition $3,080,000 has been appropriated by the various states for this purpose.

▼

Tractor-Scraper Outfit Used for Snow Removal

An outfit designed primarily for earth moving was employed recently in the city of Fargo, N. Dak., in clearing its streets of drifts and ice. As a result of many blizzards the drifts on either sides of the streets were so deep and wide that parking was impossible and traffic was almost paralyzed. To add to the difficulty most of the frozen drifts defied shovels.

The city authorities appealed to the Dakota Tractor & Equipment Co. to help them solve the problem and a "Caterpilar" RD8 tractor and Le Tourneau carryall-scraper were supplied. With the tractor straddling the drifts the scraper followed behind scooping up 12-yd. loads of ice and snow. When the bowl was full it was raised to carrying position and hauled to a nearby vacant lot or city park where the snow was dumped to await the coming of spring or an early chinook. Drifts ranged from 2 to 5 ft. deep and the haul varied from 1 to 3 blocks, but the work was completed at the rate of a block an hour and the ice and frozen snow were declared to aid, rather than hinder the job.

Tractor-Scraper Outfit Engaged in Snow and Ice Removal Work at Fargo, N. Dak.

GETTING RID OF THE "FAT SPOTS"

By ARTHUR K. ERB

Formerly District Maintenance Engineer, West Virginia State Road Commission

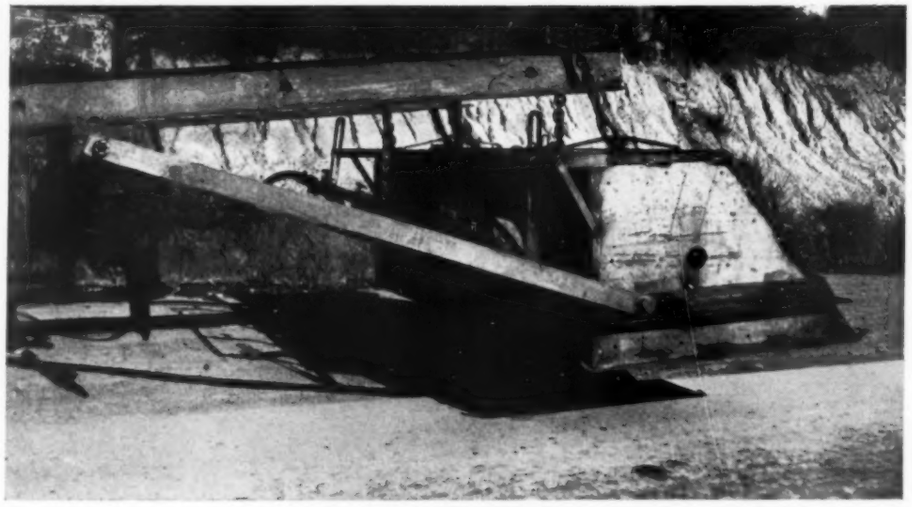
WE had a number of old macadam highways that had excess bituminous material on the road surface at several locations. We tried various expedients for removing the excess "fatness" such as rolling in limestone chips during the hottest part of the season and spraying the surface with kerosene, spreading sharp sand and rolling. These methods were uniformly unsuccessful due to the failure of the metal to properly bond itself to the bituminous material. Inasmuch as the "fat" condition was obviously due to too much bitumen in proportion to the amount of metal in place and our efforts to supply the deficiency proved futile, our only recourse apparently was to remove the excess bitumen. This we accomplished with the device described below.

The Burner Unit Was Attached to a Trailer Distributor.

It consists of a sheet steel box approximately 2 ft. wide and 6 ft. long housing four kerosene burners connected through a manifold to pressure tanks mounted on the rear of a tank trailer. The outfit was considerably more elaborate than was necessary, but the burning operation was carried on in the late autumn and was built around a trailer distributor used during the summer months, for patching. The unit was designed for spraying penetration emulsion and was equipped with a small gasoline-driven air compressor which forced the emulsion through the spray hose by air pressure. This compressor was utilized to keep pressure on the kerosene tanks, two, of 30 gal. capacity each, being used and so connected that one could be filled while the burners were being fed by the other. The pressure tanks and burners were taken from heating kettles which also were not being used at that time of year.

After some experiment we found that the average time of burning to provide a surface apparently free from enough excess bitumen to be hazardous, varied between 40 seconds and 2 minutes. The average, including moves, being 1½ minutes, or 80 ft. per hour. Immediately after moving the burner ahead, sharp sand, sized between No. 10 mesh and ¼ in., was spread at the rate of approximately 4 lb. per square yard. This treatment, the width of the burner, or 6 ft., was found adequate to provide a safe driving surface on one-half of the roadway width and after 18 months was still effective.

The cost of constructing the unit, not including the compressor, pressure tanks, etc., described above, was $127.26. The cost of an extra set of burners is included in the amount shown. A half-ton pick-up truck was used to transport the men, kerosene and sand. A truck hauled the trailerburner unit. The cost of the work including all equipment rental charges, labor and materials was $0.56 per square yard, or the equivalent of a linear foot of half the width of the pavement. These costs are based on a crew of three men, one each at $0.51, $0.45, $0.30 per hour. Sand cost $3.15 per cubic yard, F.O.B. destination, and kerosene $0.11 per gallon. The average day's work used 0.94 cu. yd. of sand, 71.5 gal. of kerosene and treated 640 lin. ft. one side.



Close-Up of the Burner Unit.

JOB AND INDUSTRIAL EMPLOYMENT IN HIGHWAY CONSTRUCTION

By T. WARREN ALLEN

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U. S. Bureau of Public Roads,
Washington, D. C.

THE Bureau of Public Roads has just lately issued a bulletin entitled, "An Economic and Statistical Analysis of Highway-Construction Expenditures," showing in considerable detail the influence exerted by an average annual Federal and State highway construction program upon our economic life. This bulletin presents very clearly the effects on basic industries of a continuing program of highway construction and contains much allied data which may be useful to public officials in determining highway policy. In particular it traces the effects of each preceding or resulting activity through each and every process from the quarry and the mine to the finished product, the highway, and shows how the total expenditure or total cost of its construction eventually goes to pay salaries and wages to labor.

Highway Construction Important Industry.—The improved highway is a product of manufacture and highway construction is therefore essentially a manufacturing industry. It is, moreover, a very important industry, for during the years 1926 to 1933 the average annual expenditure for highway construction purposes by Federal, State, county and city governments has amounted to approximately $1,350,000,000. This formed more than 50 per cent of our total average annual public construction bill for these years. How this highway construction activity has affected other lines of business and industry may be better realized when it is understood that as a result of the single item of Federal appropriations for highway improvement and since its beginning around two-thirds of a billion dollars has gone into highway contractors' equipment ownership and operating expense, and around a billion and a third into materials of construction. (See Fig. 1.)

Items in a $100,000,000 *Expenditure.*—The new bulletin shows that for the expenditure of each $100,000,000 of the annual highway construction program of the last few years, about 43,000,000 cu. yd. of excavation have been moved, 15,000,000 sq. yd. of pavement have been laid, 100 miles of galvanized culvert pipe have been put in place, and 43,000,000 lb. of reinforcing steel and 17,000,000 lb. of structural steel have been utilized in pavements, bridges and minor structures. And these are just a few of the many items which have entered into this work.

Highways Important Part of Our Economic Life.—We are accustomed to think of our highways largely or entirely in the light of their service value as traffic-carriers and thus give far too little attention to the part which highway construction and maintenance activities take in our economic life. This is a mistake. Our economic life is exceedingly complex. The various parts of it are so interdependent that any deviation from the regular procedure in any individual industry produces repercussions in very many if not virtually all of the others. A study undertaken to classify the various activities of our economic life into basic groups and to trace the influence of each of these on all other subdivisions of industry should prove of absorbing interest and of immeasurable value in guiding any future attempt at stabilization. Such a study will need to be exhaustive and of gigantic proportions, and will require the best thought of our ablest thinkers. Until such a study has been made it is doubtful if it will be possible to prescribe an effective remedy for the cure of our economic ills.

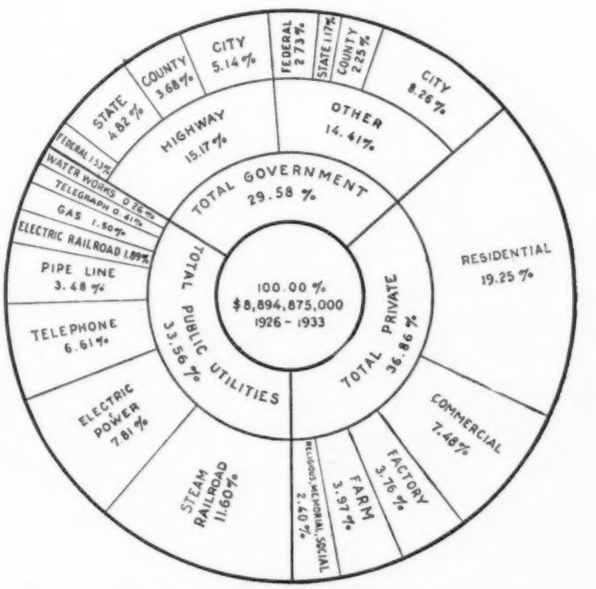

Fig. 1.—Distribution of the Average (1926-33) Annual Construction in the United States

In any classification into basic economic groups the construction industry is found to form a very important if not a paramount subdivision. Such intensive studies as have been made indicate that in general the fortunes of all industries are predicated on the fortunes of the construction industry.

Expenditures and Employment in Construction.—In the new bulletin just issued by the Bureau of Public Roads there is a chart (see Fig. 2) showing clearly the "tie-in" between the industrial debacle dating from the fall of 1929 and the drop in general construction activities which preceded it. The range there shown in money expended for all construction purposes for the years 1925 to 1933, inclusive, reveals the peak year (1928) to be about $12,000,000,000, with the low year (1933) falling to $3,000,000,000. This drop, it is estimated, resulted in a decrease of 2,800,000 in job employment, 3,800,000 in indirect employment; 200,000 in related producer goods employment; and 3,800,000 in consumer goods employment; a total of 10,600,000. To this must be added 2,400,000 whose jobs have been eliminated by changes in industrial processes.

It is believed that the economic effects of highway

*An abstract of a paper presented at the Thirty-third Annual Convention, American Road Builders' Association, Cleveland, Ohio, January 20-24, 1936.

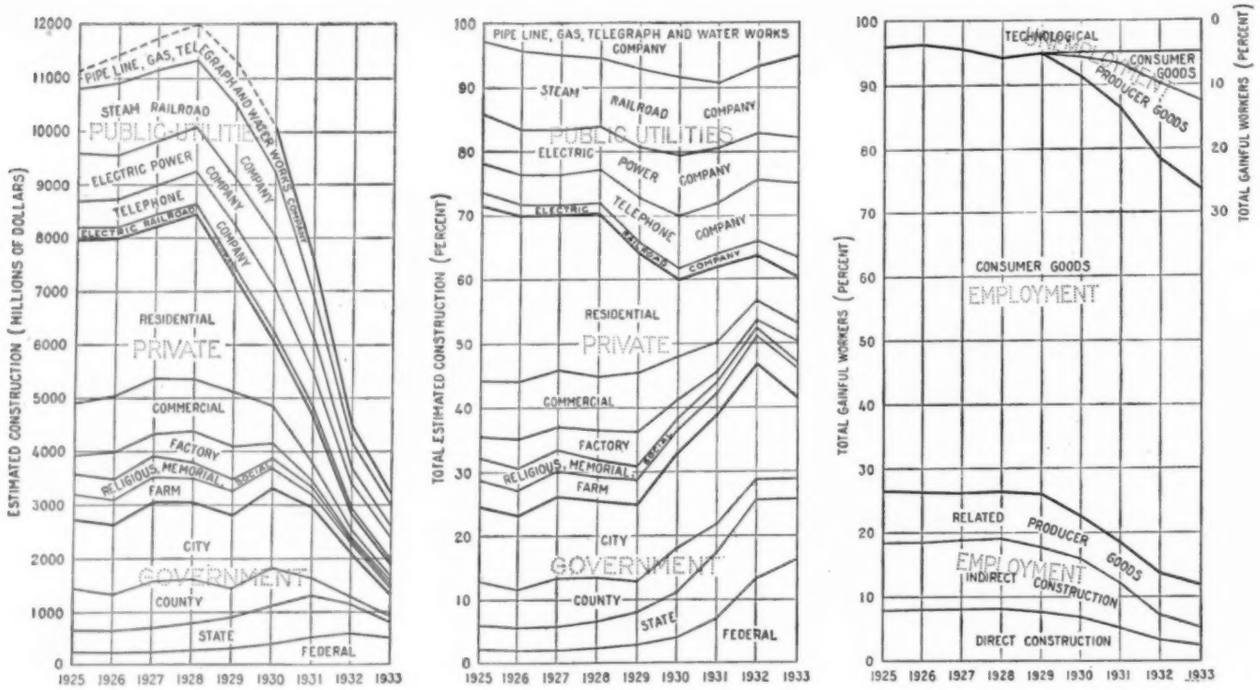

Fig. 2.—Trend of Construction and Related Employment in the United States 1925 *to* 1933

construction, which are so clearly outlined in this new Bureau of Public Roads bulletin, are not very materially different from the average economic effects produced by the whole construction industry, and in listening to my discussion of this brief analysis of highway construction one may consider in a general way that it is a discussion of the average effects of construction of all kinds.

This statement does not mean to imply that all construction items are equally effective in contributing to sustaining our economic existence. Probably it is safe to assume there is as much variation in the employment-giving possibilities of the different kinds of general construction as there is between the various types of highway construction but the average effect of the entire industry will probably not be very materially different.

Employment from Road Construction Program.—Referring again to the new bulletin, we find that the road construction program there analyzed charges direct or job labor with 24.4 per cent of the total cost and indirect or industrial labor with 50.3 per cent of the total cost, without including the labor employed in reinvestment projects. If we add the labor resulting from projects undertaken with reinvestment funds indirect labor will total 75.6 per cent.

The bulletin then proceeds to break down the total highway construction program into major subdivisions in which we find that without including labor in reinvestment fund projects, the labor employment varies all the way from 42.6 per cent for direct job labor on graded and drained unsurfaced roads with 34.4 per cent for indirect labor, 35 per cent for direct job labor on low-type surfaces with 41 per cent for indirect labor, 28 per cent for direct job labor on intermediate types with 47 per cent for indirect labor, to about 18 per cent for direct job labor on high-type surfaces with 56 per cent for indirect labor. In other words, the higher type pavements, with their greater percentage of indirect or industrial labor, throw a much greater employment into the industrial centers where it is most needed.

The labor distribution for the graded and drained but unsurfaced type of improvement cited above is that on which modern contract methods are employed with the average quantity of modern equipment during construction. But as modern equipment is replaced with more and more hand labor, the cost of direct labor eventually reaches nearly 100 per cent of the total outlay, with the natural result that the cost of indirect labor is reduced to nearly zero. Under the last-named conditions the benefit of the expenditure, apart from the evil of increased costs, is confined to the immediate locality in which the construction is done with little or no material benefit accruing to the industrial centers.

The data upon which the bulletin is based cover work done during the years 1925 to 1933 which were averaged for this purpose. It must be recognized, however, that the percentages of types being built are gradually changing. The through highway routes have been improved to a very considerable extent and work on secondary and feeder roads is now being emphasized.

Distribution of Highway Construction Expenditures.—Figure 3 shows the expense of our average highway construction operations to be divided between job labor (24.4 per cent), equipment (21.4 per cent), materials (48.7 per cent), and other expense (5.6 per cent). Job labor payments have been divided about as follows: 10 per cent to supervision, 6 per cent to skilled labor, 20 per cent to intermediate grade or semi-skilled labor, and 64 per cent to unskilled labor. Job labor has gone into grading to the extent of 8.3 per cent, surfacing 11.3 per cent, structures 4.1 per cent, and miscellaneous 0.7 per cent of the total cost.

Details of Construction Equipment and Distribution and Expense.—Figure 4 shows the details of construction equipment distribution and expense. We find that this item consists of trucks, 40.2 per cent; tractors, 9.7 per cent; equipment for bituminous paving, 3.6 per cent; concrete paving, 7.5 per cent; drilling, 3.5 per

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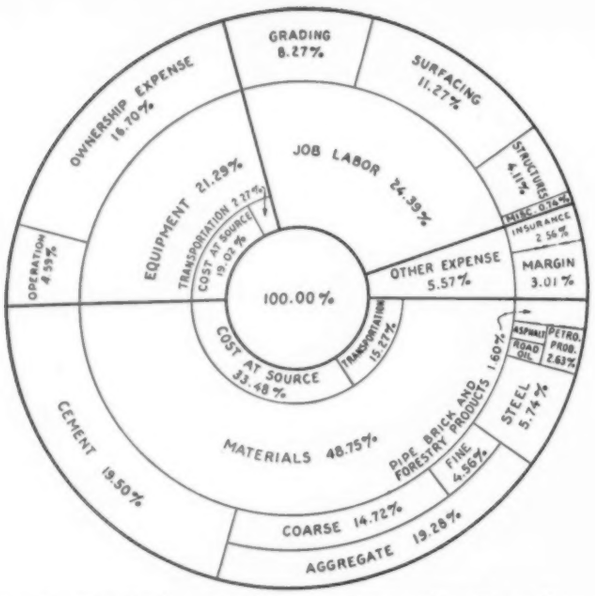

Fig. 3.—Distribution of Highway Construction Expenditures

cent; graders and scrapers, 4.6 per cent; cranes, power shovels and draglines, 19.6 per cent; and 11.3 per cent for crushing, screening and conveying, pumping, culvert and bridge and other miscellaneous equipment. On the basis of each $100,000,000 of the annual highway construction program the total equipment expense which was found chargeable against the work was $21,288,500, of which $2,272,700 or 10.68 per cent was for transportation alone. It is of interest to note that for each expenditure of $100,000,000, which by the way is less than a third of the annual Federal program of the last few years, $286,000 was paid in taxes on these equipment items alone. Incidentally it may be stated that on the total gross business turnover of about $315,600,000 which resulted from each $100,000,000 of the highway construction program, nearly $7,000,000 in taxes was collected. Tax collections on work where but little equipment is used are, however, of small importance.

Figure 5 shows the details of expenditures for materials, which amounted to an average of $48,749,000 for each $100,000,000 program. Of this expenditure for materials the cost of transportation alone (mostly railroad freight bills) amounted to $15,271,400. The costs of the materials themselves were as follows: broken stone, gravel and sand, $19,278,400; cement, $19,502,100; steel, $5,739,200; petroleum products, $2,632,800; pipe, $843,900; forestry products, $648,100; and brick, $105,000.

Other expense shown in the bulletin under each $100,000,000 of the highway construction program in addition to job labor, equipment and materials are bond premiums, compensation and liability insurance premiums, other taxes and job margin. These together total $5,572,000.

Direct and Indirect Labor from Highway Construction.—The labor used as the result of highway construction is first direct or job labor, which includes all supervisory, skilled and unskilled workers employed by the contractor on a given highway project. Subcontractors' employes who are engaged in actual construction work at the site of the job are also included.

In carrying out his work the contractor must have equipment and must purchase supplies and materials of construction. These must be fabricated and transported, and for this indirect or industrial labor is employed. Much labor is thus involved in producing the materials and in manufacturing the equipment used in actual highway construction activities. Considerable labor is also required to manufacture the equipment and to furnish the supplies required by the manufacturer of highway equipment. For example, all of the labor required to mine and convert iron ore and other raw materials into a power shovel and deliver it to the contractor ready for use is indirect labor. Practically every type of industrial activity is represented to some extent by the indirect labor arising from a highway construction expenditure.

Over and above all of the payments to such direct and indirect labor are the payments to labor engaged on reinvestment projects. In highway construction, as well as in every industry affected, an increment of the total business is drawn off in the form of interest and margin. The recipients of this increment either spend it for articles they themselves will consume or use—"consumer goods"—or they reinvest the funds in some enterprise manufacturing products required in some activity, perhaps more highway construction. The labor required in these enterprises arising from and made possible by or through the further use of these reinvestment funds is termed "producer goods reinvestment labor." Thus, indirect or industrial labor arises directly from the requirements of highway construction activities, while producer goods reinvestment labor results in any industry or activity in which the entropreneur or investor chooses to invest his profits or interest. For example, the highway contractor or the manufacturer of the cement required in the highway work may invest his profit from this source in a concern building locomotives or mining lead, and the labor thus employed is arbitrarily termed "producer goods reinvestment labor." However, it is labor which would not have been employed except for the expenditure of public funds for highways.

Again, the portion of the interest and margin payment that is spent for articles to be used by the purchaser requires activity in the "consumer goods industries" results in payments to labor by these industries. Thus, a bondholder of a plant manufacturing cement for highway purposes may spend his interest payment from this

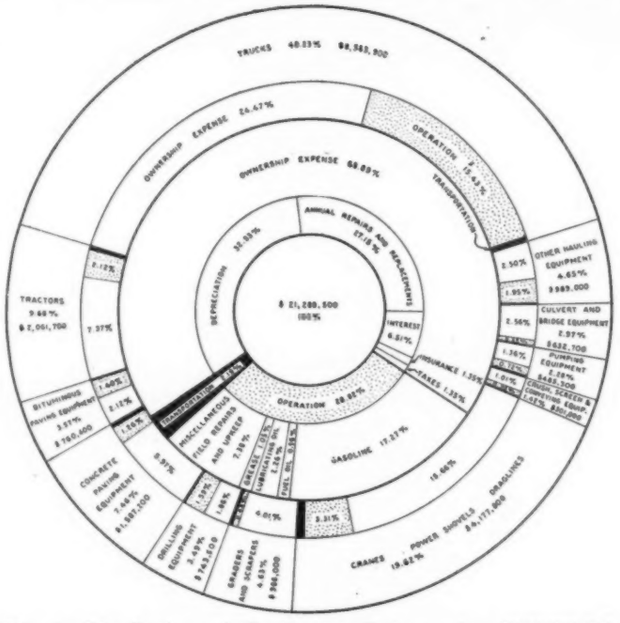

Fig. 4—Distribution of Equipment Expense for $100,000,000 Highway Construction Expenditures. Stippling Indicates Operation Costs and Black Indicates Transportation Costs.

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Fig. 5.—Distribution of Material Expense for $100,000,000 *Highway Construction Expenditure*

source to defray the regular costs of living; i. e., to purchase food and clothing. The labor involved in supplying this is termed consumer goods labor. Again this is labor which would not have been employed except for the highway construction program.

The results of the analysis as given in this new Bureau of Public Roads bulletin are expressed in terms of an $100,000,000 program so that they may be easily translated into terms of a program of any size. On this basis job labor received $24,391,000; equipment, $21,288,500; materials, $48,748,500; and other expenses amounted to $5,572,000. For an expenditure of $10,000,000 these amounts would be one-tenth as great.

The statement is also made that this total expenditure eventually goes to labor. It goes in payments directly to the labor on the job, to the labor indirectly employed as defined above, to the labor employed in the manufacture of producer goods, and to the labor employed in the manufacture of consumer goods. In the bulletin a thorough analysis is made of all expenditures and the steps taken in arriving at the results are shown in detail in the various breakdowns given in the bulletin. The combined result is shown in Table I. It shows the total payment to labor in each of the major industries involved in highway construction and again exhibits the broad influence exerted on industry by such construction.

Employment Created by Highway Program Expenditures.—Table II shows the employment created by the highway program expenditures and the indirect employment here shown includes the employment on reinvestment funds projects. This is shown graphically in Fig. 6.

In this table we find that for a continuous annual expenditure of each $100,000,000 there were provided a continuous job employment on the average of 37,960 men and a continuous indirect employment of 64,730 men, or a total continuous annual employment of 102,690 men.

This, however, is not the whole story. The requirements of highway construction cause, as we have already seen, many business transactions in addition to the highway business transacted on the job. Each order for highway materials initiates the transaction of business in numerous places and in many industries. As the result of an order for steel, iron ore mining operations are stimulated and business of value is transacted.

Fig. 6.—Distribution of $100,000,000 *Highway Construction Expenditure Until Ultimately Paid to Labor*

TABLE I.—ULTIMATE DISTRIBUTION TO SALARIES AND WAGES OF $100,000,000 HIGHWAY CONSTRUCTION EXPENDITURE.

		To salaries and wages through			
Industry	Direct	Investment in producer goods	Reinvestment in producer goods	Reinvestment in consumer goods	Total
Highway construction	$24,391,000	$.....	$.....	$.....	$24,391,000
Transportation	.....	13,489,600	3,973,700	1,596,900	19,060,200
Plant and equipment	.....	11,169,000	3,290,100	1,544,100	16,003,200
Aggregate, quarrying	.....	5,538,000	1,631,400	34,200	7,203,600
Insurance and taxes	.....	4,486,500	1,321,700	698,600	6,506,800
Cement	.....	3,681,000	1,084,400	14,600	4,780,000
Iron and steel	.....	2,707,100	797,500	194,800	3,699,400
Petroleum products	.....	1,852,200	545,600	152,700	2,550,500
Coal and coke	.....	1,821,000	536,400	197,400	2,554,800
Power	.....	534,900	157,600	128,800	821,300
Metallicore mining	.....	1,030,200	303,500	232,000	1,565,700
Forestry products	.....	1,067,300	314,400	210,000	1,591,700
Advertising and development	.....	831,400	244,900	172,900	1,249,200
Explosives	.....	465,600	137,200	19,200	622,000
Laboratory	.....	567,200	167,100	34,900	769,200
Rubber	.....	314,500	92,600	43,400	450,500
Brick	.....	283,800	83,600	32,500	399,900
Agricultural products	.....	172,600	50,800	459,700	683,100
Pipe	.....	135,200	39,800	.....	175,000
Nonferrous-metals refining	.....	122,300	36,000	12,500	170,800
Container	.....	65,600	19,300	2,900	87,800
Retail trade	.....	.....	.....	2,334,500	2,334,500
Wholesale trade	.....	.....	.....	767,400	767,400
Manufacturing	.....	.....	.....	1,562,400	1,562,400
Total	$24,391,000	$50,335,000	$14,827,600	$10,446,400	$100,000,000

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TABLE II.—EMPLOYMENT RESULTING FROM AN ANNUAL HIGHWAY CONSTRUCTION EXPENDITURE OF $100,000,000.

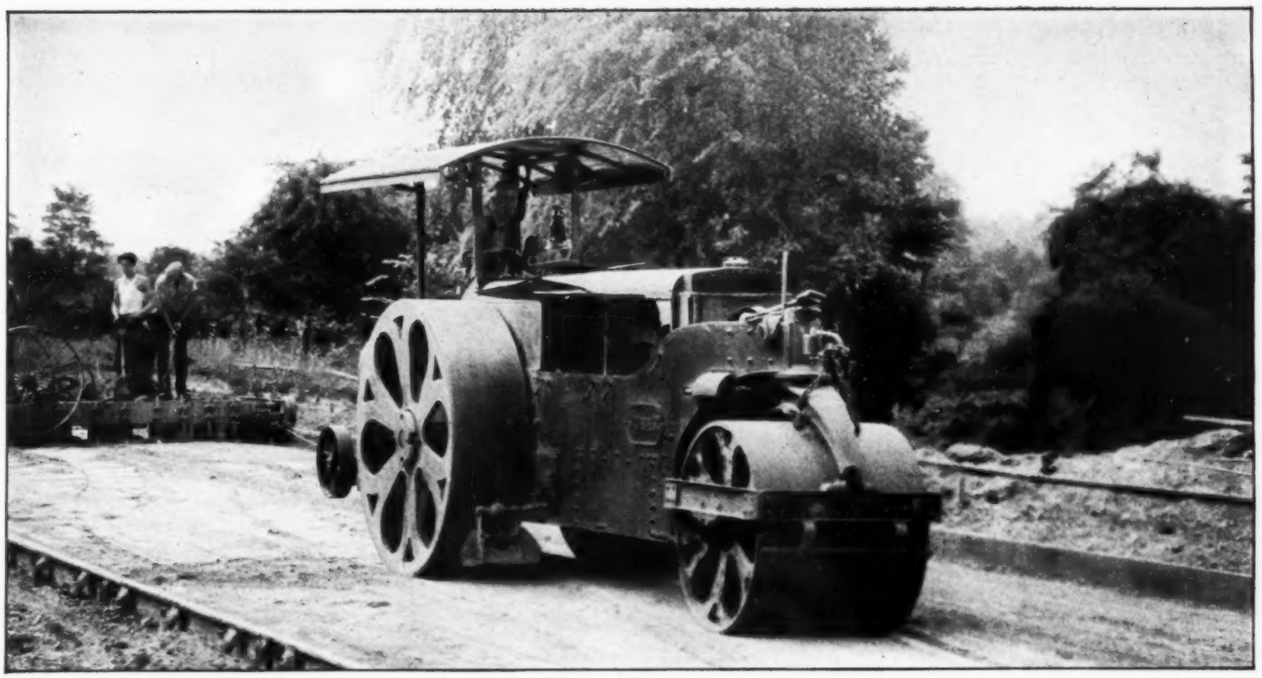
Industry	Salaries and wages	Rate per hour	Man-hours Number	Hours per week Number	Rate per week	Man-weeks Number	Rate per month	Man-months Number	Rate per year	Man-years Number
Direct labor	$24,391,000	$0.48	50,870,000	25.8	$12.36	1,973,900	$ 54	455,500	$ 640	37,960
Indirect labor:										
Transportation	19,060,200	.64	29,877,000	44.1	28.14	677,300	122	156,300	1,460	13,030
Plant and equipment	16,003,200	.62	25,647,000	37.0	23.07	693,700	100	160,100	1,200	13,340
Aggregate, quarrying	7,203,600	.48	14,976,000	32.7	15.73	458,000	68	105,700	820	8,810
Insurance and taxes	6,506,800	.86	7,531,000	39.3	34.00	191,400	147	44,200	1,770	3,680
Cement	4,780,000	.57	8,430,000	33.2	18.80	254,200	81	58,700	980	4,890
Iron and steel	3,699,400	.61	6,093,000	33.9	20.59	179,700	89	41,400	1,070	3,450
Petroleum products	2,550,500	.72	3,567,000	38.1	27.26	93,600	118	21,600	1,420	1,800
Coal and coke	2,554,800	.60	4,265,000	30.3	18.13	140,900	79	32,500	940	2,710
Power	821,300	.72	1,136,000	42.5	30.73	26,700	132	6,200	1,600	510
Metallic-ore mining	1,565,700	.57	2,756,000	39.5	22.42	69,800	97	16,100	1,170	1,340
Forestry products	1,591,700	.44	3,618,000	32.5	14.28	111,500	62	25,700	740	2,140
Advertising and development	1,249,200	.84	1,494,000	39.4	33.00	37,900	143	8,700	1,720	730
Explosives	622,000	.68	917,000	34.3	23.24	26,800	101	6,200	1,210	510
Laboratory	769,200	.61	1,261,000	40.7	24.83	31,000	108	7,200	1,290	600
Rubber	450,500	.73	613,000	30.2	22.15	20,300	96	4,700	1,150	390
Brick	399,900	.43	921,000	31.6	13.72	29,100	59	6,700	710	560
Agricultural products	683,100	.12	5,509,000	72.3	8.96	76,200	39	17,600	470	1,470
Pipe	175,000	.61	289,000	34.4	20.88	8,400	91	1,900	1,090	160
Nonferrous-metals refining	170,800	.53	319,000	37.1	19.94	8,600	86	2,000	1,040	170
Container	87,800	.50	176,000	34.5	17.34	5,100	75	1,200	990	100
Retail trade	2,334,500	.51	4,595,000	39.4	20.03	116,600	87	26,900	1,040	2,240
Wholesale trade	767,400	.64	1,203,000	41.3	26.38	29,100	114	6,700	1,370	560
Manufacturing	1,562,400	.55	2,841,000	35.5	19.51	80,100	84	18,500	1,010	1,540
Total or average	$75,609,000	$0.59	128,034,000	38.0	$22.46	3,366,000	97	776,800	1,170	64,730
Grand total or average	$100,000,000	$0.56	178,904,000	33.5	$18.73	5,339,900	81	1,232,300	970	102,690
Ratio, direct labor to indirect labor	1:3.10	1:1.23	1:2.52	1:1.47	1:1.82	1:1.70	1:1.82	1:1.70	1:1.82	1:1.70

The transportation of iron ore from the mines to the smelter adds to the value of the business transacted. The pig-iron manufacturer causes the transaction of business in the conversion of iron ore, requiring the application of additional labor to plant and equipment. There may or may not be an additional transaction of business in the transportation from the smelter to the steel mill. At the steel mill there is further required the application of labor and equipment to these materials before the order from the highway contractor can finally be loaded on the railway cars for final shipment. Each successive stage in the processing of materials represents the distribution of expense to labor, equipment, materials and other expense, which items compose the cost of doing business. The total value of business thus transacted is the sum of the separate item values involved in the several stages required for the complete processing of materials. Thus for each highway construction item of $100,000,000 the average total value of all business transacted, including reinvestment projects, totals about $315,602,700. The amounts for each industry by classes of labor are shown in Table III.

The turnover value of this total business resulting from highway construction expenditures increases with high types of construction and is relatively small for those low types which use little equipment and require

TABLE III. VALUE OF BUSINESS RESULTING FROM AN EXPENDITURE OF $100,000,000 FOR HIGHWAY CONSTRUCTION

Industry	Original expenditure	Value of business created by— Producer-goods investment	Producer-goods reinvestment	Consumer-goods reinvestment	Total
Highway construction	$100,000,000	.....	.....	.....	$100,000,000
Transportation	.....	$ 26,061,800	$ 7,677,200	$ 3,085,500	36,824,500
Plant and equipment	.....	27,707,600	8,162,100	3,830,800	39,700,500
Aggregate, quarrying	.....	13,267,600	3,908,300	81,800	17,257,700
Insurance and taxes	.....	9,545,700	2,812,000	1,486,200	13,843,900
Cement	.....	14,759,900	4,347,900	58,400	19,166,200
Iron and steel	.....	11,941,600	3,517,700	858,200	16,317,500
Petroleum products	.....	6,215,000	1,830,800	512,200	8,558,000
Coal and coke	.....	2,965,000	873,400	321,500	4,159,900
Power	.....	2,470,900	727,900	594,500	3,793,300
Metallic-ore mining	.....	2,872,000	846,000	646,700	4,364,700
Forestry products	.....	2,014,200	593,300	396,200	3,003,700
Advertising and development	.....	2,218,500	653,500	461,300	3,333,300
Explosives	.....	2,265,200	667,300	93,800	3,026,300
Laboratory	.....	1,531,900	451,300	94,800	2,078,000
Rubber	.....	1,491,500	439,400	205,800	2,136,700
Brick	.....	610,100	179,700	70,000	859,800
Agricultural products	.....	712,200	209,800	1,897,800	2,819,800
Pipe	.....	727,500	214,300	.....	941,800
Nonferrous-metals refining	.....	1,330,400	391,900	135,100	1,857,400
Container	.....	310,800	91,600	12,500	414,900
Retail trade	.....	.....	.....	16,348,000	16,348,000
Wholesale trade	.....	.....	.....	9,838,300	9,838,300
Manufacturing	.....	.....	.....	4,958,500	4,958,500
Total	$100,000,000	$131,019,400	$38,595,400	$45,987,900	$315,602,700



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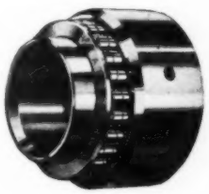

All new equipment should be able to perform well, but the real test of its mettle is how well it will operate in the years to come. With this thought in mind, the designers of today's mechanical devices turn to Hyatt Roller Bearings to endure the merciless punishment of steady operation, shock loads, and the toughest going . . . without perceptible wear and without continuous care. It is significant, therefore, that designers of equipment invariably turn to Hyatts when the going promises to be tough. Hyatt Roller Bearing Company, Newark, Detroit, Chicago, Pittsburgh, San Francisco.

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but little auxiliary work either in the production of materials or in their transportation. On the other hand, these turnover values increase very rapidly with those higher types of construction which utilize much modern equipment on the job and require the purchase of materials which provide auxiliary employment in plants and factories, in mines and quarries, in cement mills, in iron and steel mills, in petroleum plants, in transportation, on farms, or in a myriad of other sources.

In highway construction work the selection of types should therefore be based entirely on traffic requirements and on the economic superiority of the various possible types, while the methods employed in their construction should be based on no other criteria save those of the quality of the resulting product and on the effect of these methods on the efficiency of operation and unit production costs.

But, valuable as highway construction is in giving employment to those out of work, it is not so much of this particular phase that I have been speaking as of the larger part it plays in our economic life as a regularly established manufacturing industry the product of which is the completed highway, a permanent national asset of inestimable value which more than any one thing fosters our advancement in civilization; and finally, and perhaps best of all, this asset comes to us almost as a present, for through the collection of registration fees, gasoline and other taxes, it is self-sustaining.

▼

Spraying and Burning Highway Roadside Vegetation

California in common with other western states, having an arid summer season, has a special problem in the reduction of fire hazards to property and watershed cover along the roadsides. The spraying and burning of roadside vegetation for the 1936 season is now underway in California. This work, which involves protective measures along 1,100 miles of state highways, at an annual expense of some $80,000, has been a regular part of the Division of Highways Maintenance program since 1929. Some interesting information on this work is given by W. A. Smith, Assistant Maintenance Engineer, in the February issue of California Highways and Public Works, from which these notes are taken.

The purpose of this roadside spraying and burning is to provide a firebreak between the highway and adjoining property. Its justification lies in the protection afforded the property owner or public interests against the increased hazard due to volume of motor traffic which improved highways bring, as well as in prevention of erosion damage to highways at locations where natural cover may be destroyed by fire, and also in the fact that insurance rates on grain lands are thereby kept to a lower level.

In general, no spraying is done opposite locations where a natural or artificial firebreak already exists, either adjacent to or within a reasonable distance of the right of way. It is considered that the clearing of vegetation from locations adjacent to orchards, vineyards, plowed land, railroad rights of way, or streams which parallel the highway is not justified, as reasonable protection already exists.

Likewise, bare cut slopes 5 ft. or more in height present a natural obstruction against fires being started by passing traffic.

Spraying and burning can only be carried on, to advantage, over grassy areas. Where brush abounds, clearing is the only effective measure and, when that is done at considerable expense, the area is exposed to the growth of grass and a more hazardous condition is thus created.

Under conditions encountered in California where the vegetation drys up rapidly with the coming of the first hot days of the season, it is necessary to spray a strip to either kill or dry out the grass sufficiently so that it may be burned while adjacent areas are still too green to present a hazard. This strip is ordinarily 9 ft. in width, immediately adjacent to the fence lines and was adopted as being the maximum which can be handled by means of the spray bar equipment.

The location adjacent the fence lines includes the area of heaviest vegetation and also permits burning of the section between the shoulder and sprayed area later, if that seems desirable.

It must be borne in mind that efforts are directed simply to creating a firebreak. It is not desired to sterilize the soil, since at many locations it may not be necessary to spray another season. On account of the appearance, there are many individuals and some organizations who roundly criticize the work.

For most effective and economical results, the spray material should be applied when the vegetation is about 2 in. high. At that time the area can be uniformly covered; the growth is tender and practically a perfect kill is assured. There is the further advantage at this stage that no burning is required, although it may be necessary later to go over certain low areas where moisture starts a new growth.

The material used is a Diesel oil having the following specifications to insure a uniform material of adequate toxic effect:

Specific gravity (A. P. I) at 60° F.	Not less than 27° Be.
Flash point (Penskey-Martin closed cup)	Not less than 150° F.
Viscosity (Saybolt Universal) 100° F.	Not more than 50 sec.
Distillation—90% point	Not over 680° F.
Water and sediment	Not more than a trace

The Diesel oil is applied at the average rate of 0.1 gal. per square yard of area to be treated by means of tank truck outfit equipped with pressure pump and spray bar. The spray bar is fitted with orchard type spray nozzles designed to give a uniform spread. To insure such a spread, it is necessary that the position of the spray bar be adjustable so that it may be readily raised or lowered and reach out to varying distances from the roadway.

After the oil is applied, it is allowed to penetrate and act on the vegetation, which gradually turns brown. Burning operations, if required, are then started.

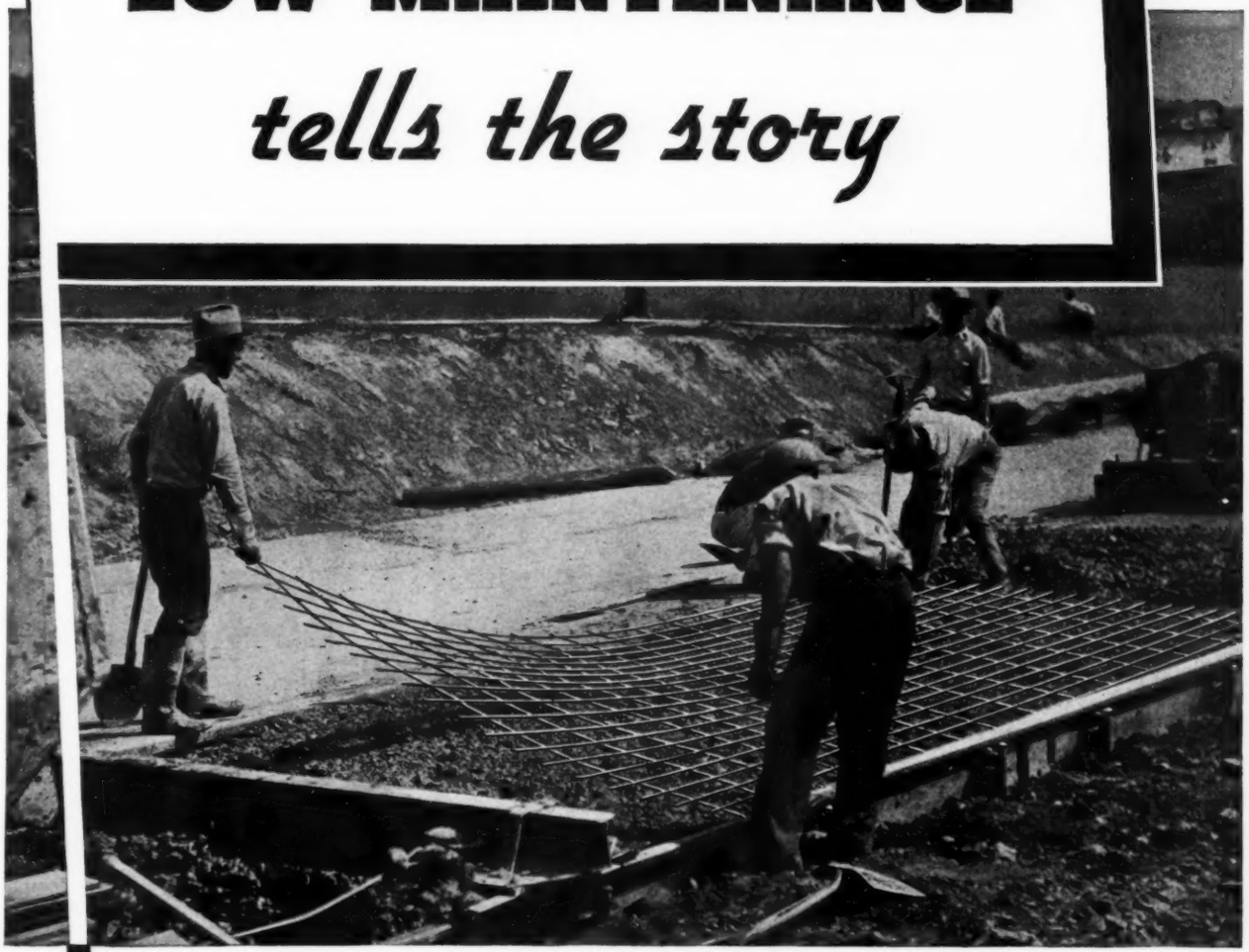
Under existing legal restrictions, any damage which results through negligence of an individual in the State service is a direct responsibility of that individual. Special care is taken, therefore, to see that adjoining property, fence posts, trees, etc., are properly safeguarded, as well as provision made for the protection of traffic. Knapsack type pumps or fire trucks are provided for each crew, and flagmen warn and direct traffic.

The cost of spraying averages from $50 to $60 per road mile of two 9-ft. strips, and burning operations cost about $20 per road mile, or a total of $75 to $80.

In addition to the areas where spraying is necessary, a considerable mileage is also protected during the regular maintenance operations by blading, disking, or mowing. Protection by this means is considerably cheaper in first cost, averaging about $6 per road mile for a reasonable width.

LOW MAINTENANCE

tells the story



There can be no question of choice between mesh-reinforced pavement and plain pavement when cost of maintenance is considered. Cost of repairing the rapidly disintegrating slabs of plain pavement far outweighs the slight additional cost of mesh reinforcing. In one state highway department, where accurate record of maintenance costs was kept over a period of years, it was found that the average annual cost of maintaining plain pavement was $2.55 per 100 square yards, as compared with 70 cents for reinforced pavement! This more-than-trebled maintenance cost means earlier replacement of the plain pavement.

Pittsburgh (National) Reinforcing serves to prevent progressive disintegration by holding incipient cracks tightly closed. It is made of cold-drawn steel wire, accurately spaced and rigidly welded at the joints. Because of the close spacing of comparatively small members, Pittsburgh Reinforcing provides a more effective reinforcement than larger members widely spaced. For a more complete description, send in the coupon.

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SAFETY AND THE HIGHWAY MACHINE

By W. W. CROSBY

Consulting Engineer, Corando, Calif.;
Formerly State Highway Engineer of Maryland

SOME 40 years ago public attention was being focussed by the press on the horrible accidents so frequent in factories, mills, and other installations of machinery. Grewsome tales were printed about scalps torn off by flying belts, fingers and hands cut off by saws and planing-machines, and arms mangled and even of men being killed by being caught in open gears.

Laws were demanded—and passed—requiring safeguards to be placed around such machinery for the protection of the operators and of those approaching it. And, in recent years, but little has been heard of such accidents, so successful have been the safeguards of various kinds, which have been installed, or so efficiently has the re-designing of the machinery itself been done with regard to making it safe to approach and to use.

And Now the Highways.—Nowadays a similar situation seems to exist as regards our highways. The press—including the periodicals—have added "and Sudden Death" to the headlines of "Battle" and "Murder." "There ought to be a law"—several of them—"Education" and "Discipline" and "More Law Enforcement" are being clamored for in the interest of preserving the race, or at least the better part of it, from extinction. Under such titles as "Highway Safety," "Accident Prevention," "Traffic Control," much space in the press is devoted to demands and ways for remedying the situation that is so appalling with its accident records.

Law-making is, of course, one of the most popular national pastimes, regardless of our experience with law-enforcement. It has even been urged that "mechanical governors" be built into automobiles so that a speed of over, say, 40 (or 60) miles per hour would be an impossibility. This seems to match some "brain-trust" ideas (killing pregnant sows, for instance) when it is analyzed and its various repercussions are clearly seen.

The Highway System as a Machine.—A highway system is a sort of machine. There is a similarity between it and a "conveyor" of ore, grain, or materials, and even to a transmission-line for electricity. The roads carry potentially dangerous "live" loads whose "voltage" (pressure or speed) and "amperage" (quantity or numbers) are high, increasing, and hazardous among themselves and to others.

Protection—for the operators, participants, onlookers, and for society in general, i. e., "safe-guarding" or "insulation," has now evidently begun to be necessary under modern and approaching conditions.

Highway authorities, who for the past 40 years in this country have been mainly concerned with putting the highway machine into efficient "productive" condition, have here and there waked up to the need for protecting or insulating it so as to make it "safe to have around."

Prescribing for the Symptoms.—Naturally enough—if perhaps unfortunately in some respects—most of the prescriptions have been made (and put up) for the symptoms rather than for the causes of the troubles. "Regulation" and "control" to prevent accidents and damage are far more often initiated than are improvements in the design of the highway machine to insure greater safety, or than are real physical safeguards which would prevent operators and "innocent by-standers" from damaging contacts with the swift-moving parts of it.

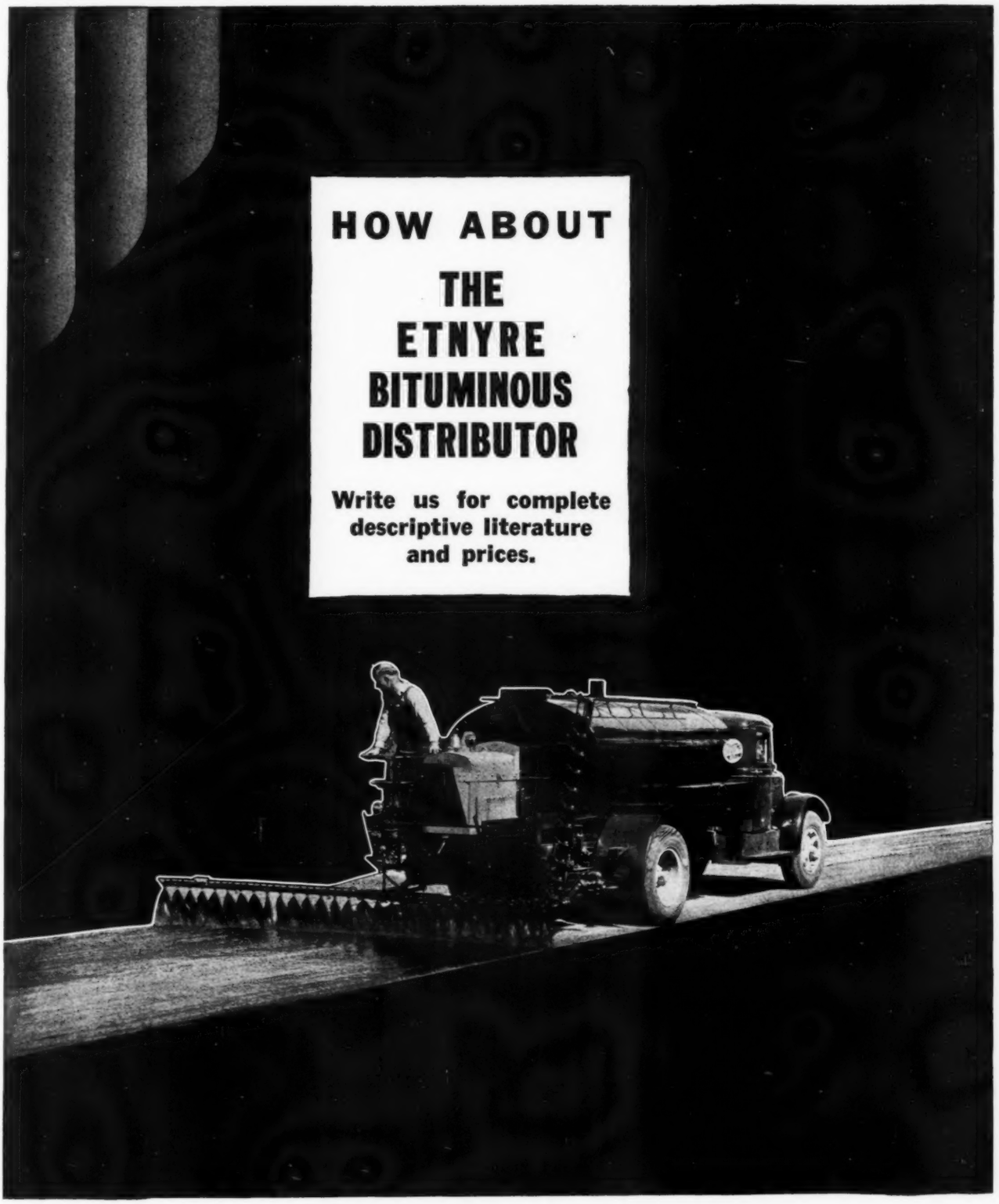
Both rules and automatic physical protection are, of course, necessary for the Highway Machinery, just as they are for saws and planers in a mill, where rules require operators' fingers to be kept away from the cutters, and "guards" supplement the rules. But rules and laws are not as effective in many such situations as are automatic physical safeguards, and often they merely stimulate transgressions as does a "Wet Paint" sign.

Relative freedom from danger—even safety—can be secured in the case of the Highway Machine by automatic physical means much more effectively than by law, police regulations, education, or discipline. For illustration, consider the separation of grades at railway crossings.

For many years the writer has been urging wider rights-of-way as a means of furthering the interests of higher efficiency of our highways and, particularly, of greater safety on them. Without space for proper construction and "Elbow Room" to move in, safety only *decreases* rapidly in proportion to traffic increases. He has urged separated roadways on main highways, for opposing traffic-streams, to obviate head-on-collisions, to reduce "side-wiping," and for many other reasons. He now wishes to emphasize the need for still wider rights-of-way in which the highway authorities may install and maintain public safeguards that will automatically reduce the dangers to operators and increase the safety of the whole Highway Machine.

Protecting the Pedestrian.—A regrettable proportion of highway accidents comes from pedestrian or other discordant intrusions—often made too suddenly and too carelessly—into the dangerous and rapid traffic-currents (or "parts") of the highway mechanism. These deplorable results can be prevented, automatically and without the need for policemen, by making the interference physically difficult or impracticable through safety devices similar to those guarding mill machinery. Mere distance or space will do it in some cases. Fences or hedges will answer in others. Walls will sometimes be needed. All require room or right-or-way.

For illustration: If the swiftest highway traffic on our main roads shall be segregated in freeways along the central axis of a (say) 300 ft. wide right-of-way; the slow local traffic provided with separate roadways for its convenience outside the freeways; the local business and pedestrians kept "back of the curbs," i. e., outside of the vehicular traffic; and the playing children, animal



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pets, the dawdlers, and the on-lookers provided for further outside and away from the vehicular traffic itself, i. e., between the business zone and the abutting private property, would not the safety of all and the efficiency of the Machine as a whole be greatly advanced?

Insulating Opposing Traffic.—On such a highway the swiftest-moving and dangerous through-traffic would be provided with and confined to the central lanes. The opposing traffic currents would be "insulated" from each other (and from the slower local traffic) by planting-spaces. Head-on collisions would be brought down to the irreducible minimum. The slow-traffic lanes, outside the through-traffic lanes, could be connected with the latter at suitable intervals for the transformation of either class either way and for the collection of dispersion of the main road traffic laterally. Still further outside would be the shopping traffic, the pedestrians, and the loiterers, successively insulated by planting-strips. The last would provide for beautification, glare- and noise-reduction, and similar desirable protection of both highway-users and adjacent property residents. "Roundabout" connections for light-traffic over intersecting roads would be easily practicable, and separated-grade crossings would be practicable where needed.

The ideal above sketched must be aimed at and eventually adopted—Why not now?

Some of the ideas above suggested have obtained recognition in places. The advantages of Westchester County's parkways are widely admired. Germany is building express highways with separated roadways. Italy's "Autostrada" restrict approach and contact from their sides, as does the elevated roadway on West St., New York City. Many cities have come to "one-way streets." Even "Boulevard Stop" signs and "White Lines" some recognition of the principles involved.

Among 25 million motor-drivers, it is reasonable to believe that there will always be some gamblers, some careless, some unfit, some in an unusual hurry, some dilatory, some inattentive, and many inconsiderate, whom laws and education will not reform nor even control effectively. Automobile manufacturers recognize the facts and try to make the automobile itself safe. Tire makers are doing likewise.

It is time for Highway Authorities to collaborate effectively and to try to avoid such conflicts of effort and waste as have been too often regrettably evident. Let the Highway Authorities develop and exhaust their ingenuity and all possible resources for locating and for designing highways to furnish convenient, efficient, and *safe* use by modern traffic in all its variety. Then let the police control that may be needed by humanity be supplemented.

The old ideal of the "Broad Highway,"—in the sense of a wide, single roadway for a heterogeneous mixture of all using it—is now obsolete. In the sense of a public right-of-way wide enough (with setback lines for buildings) to allow segregation of traffic and safeguards of various kinds to be maintained within its limits, its importance is not only enormous but is growing.

It is probably wise for the writer to state here that he has no intention of suggesting that all roads and streets should be made 300 ft. wide. There are many instances where the public right-of-way should be wider. There are more where it must be less, and, perhaps no greater than now exists. But the principles suggested toward the end of safety still apply. "Double-decking"; removal of parking from the public way to private property; segregation of traffic on separate streets, and many other instances of ingenuity to overcome lack of width are possible and have often been evident. They have become necessary by the failure to secure enough width before developments took place to make its later acquisition impracticable. These later expedients are usually tremendously expensive—compared with right-of-way costs when the width is sought in advance of the improvement of the highway—but if the room inevitably needed for Safety's sake is not to be had, they are unavoidable in the end.

Recognition of the principles above outlined has been shown by that planning genius, Fritz Malcher. Their application in cities, as well as in open country, is admirably detailed in "The Steadyflow Traffic System,"* which is respectfully recommended by the writer to all those who may not be familiar with it and wish to pursue the subject farther in detail.

The Four E's.—It is asserted that the Efficiency of our highways (including reasonable safety) depends on four other "E's," i. e., Education, Enactment, Enforcement, and Engineering. The writer is naturally and for the moment at least inclined to emphasize the importance of the last one. He believes that good Engineering minimizes the needs for recourse to the others.

The first essential now toward safer highways is that, in by-passes and new locations for all Federal highways at least, when the land can be had at a reasonable figure, wide enough rights-of-way shall be obtained in advance. The next, is to regard and to design the Highway Machine—not merely the roadway—toward the end that it shall as a whole provide the maximum of safe usability for all. After this shall have been accomplished, we may have to put dependence on education, legislation, and on "G-Men" for restraining the criminally inclined driver and for protecting at least the rest of us, if not the "Fool from his Folly."

*Published by the Harvard University Press, Cambridge, Mass.

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Highway Research Board Elects New Members of Excutive Committee

At the 15th Annual Meeting of the Highway Research Board, W. W. Mack, Chief Engineer of the Delaware State Highway Department, and F. C. Lang, Engineer of Tests and Inspection, Minnesota State Highway Department and Professor of Highway Engineering, University of Minnesota, were elected to membership on the Executive Committee to succeed H. G. Shirley and C. J. Tilden. A. J. Brosseau was re-elected to succeed himself. The officers and Executive Committee of the Board for 1936 are as follows:

Chairman—H. C. Dickinson.

Vice-Chairman—Burton W. Marsh.

Director—R. W. Crum.

T. H. McDonald, Chief, U. S. Bureau of Public Roads.

Maurice Holland, Director, Division of Engineering and Industrial Research, National Research Council.

T. R. Agg, Dean, Division of Engineering, Iowa State College.

George E. Hamlin, Deputy Commissioner for Maintenance, Connecticut State Highway Department.

A. T. Goldbeck, Director, Bureau of Engineering, National Crushed Stone Association.

Charles M. Upham, Engineer-Director, American Road Builders' Association.

A. J. Brosseau, President, Mack Trucks, Inc.

F. C. Lang, Engineer of Tests and Inspection, Minnesota Highway Department.

W. W. Mack, Chief Engineer, Delaware State Highway Department.

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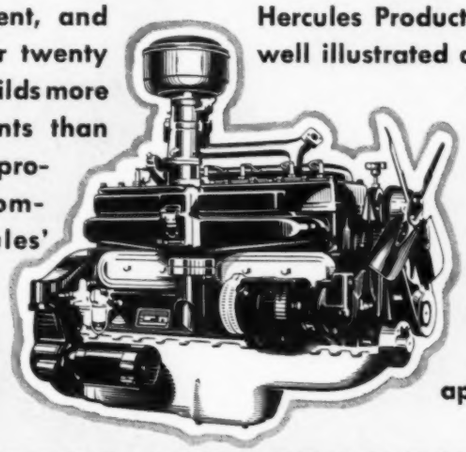

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Dover-Sherborn Bridge

THE DOVER-SHERBORN BRIDGE

WOOD-TRIMMED CONCRETE DECK GIVES APPEARANCE OF A RUSTIC TIMBER STRUCTURE

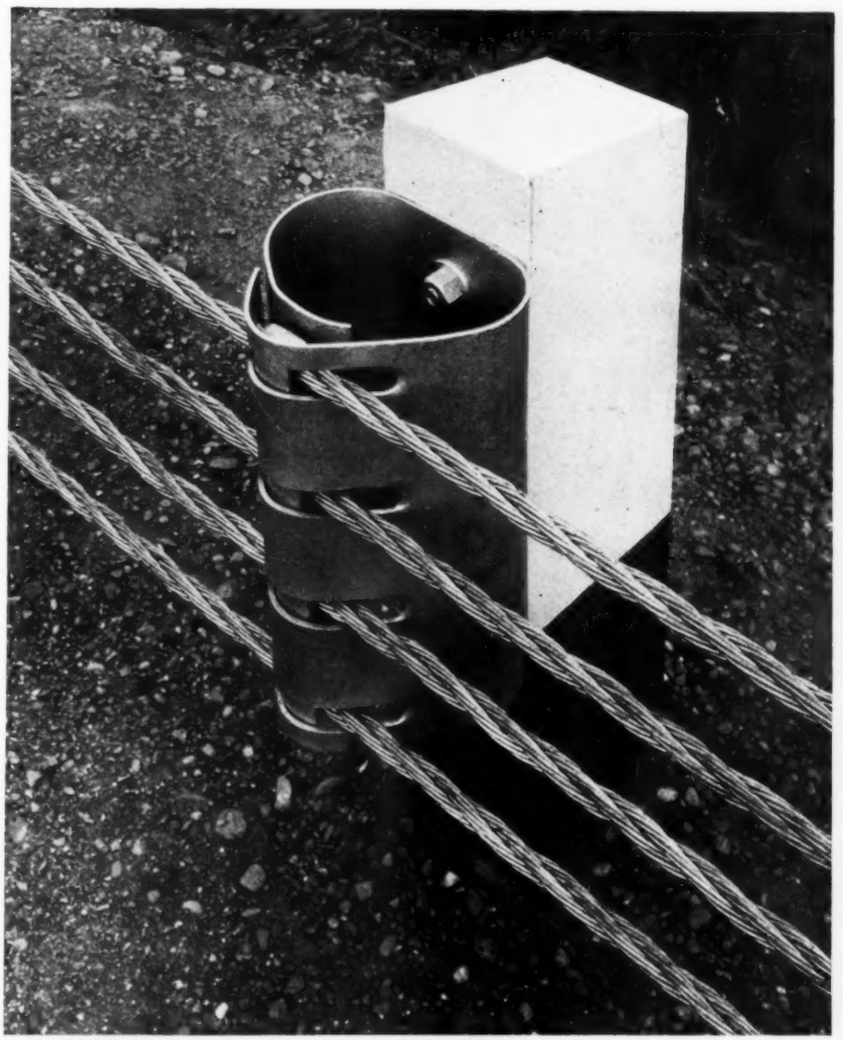
THE Farm Street Bridge over the Charles River between Dover and Sherborn, Massachusetts, combine serviceability, economy and beauty. There are 7 bents of creosoted timber piles, with concrete caps and deck slab. The guard rails and posts are of hewn oak, while the edges of the deck, and sides and ends of the caps are faced with the same material, giving the appearance of an all-timber bridge. The road surface is a 2 in. bituminous mix. Sidewalk is gravel.

The length over all is 97 ft. 6 in., width over all 38 ft. 8 in., roadway width 30 ft., sidewalk (one side only) 5 ft., slab width 38 ft. 0 in. The design is for a 15-ton truck loading. Volume of traffic is very light.

Twelve inch piles were used throughout. They are

Dover-Sherborn Bridge

Looks *Safer*...is *Safer!*



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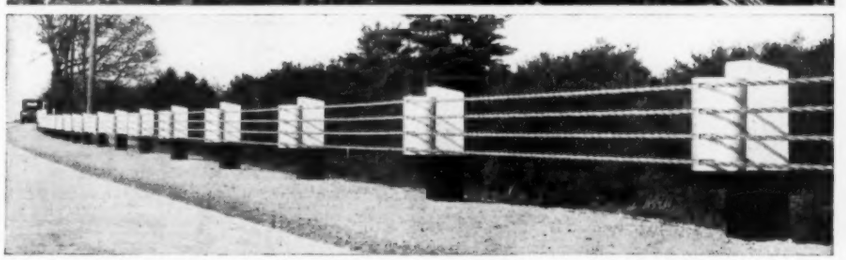

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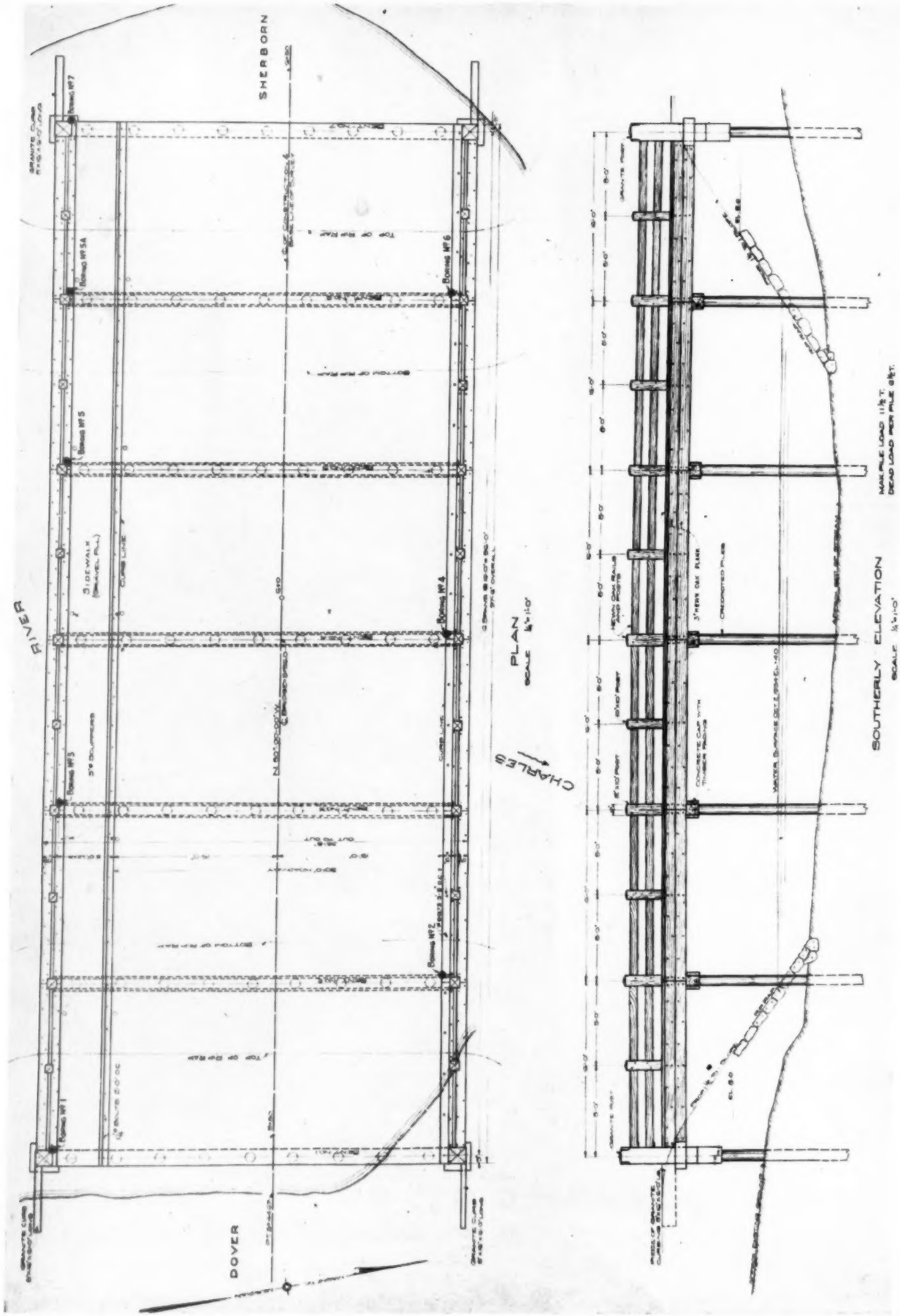

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Safety Worm Boom Hoist—Positive Spring Lock—Cab in any position.
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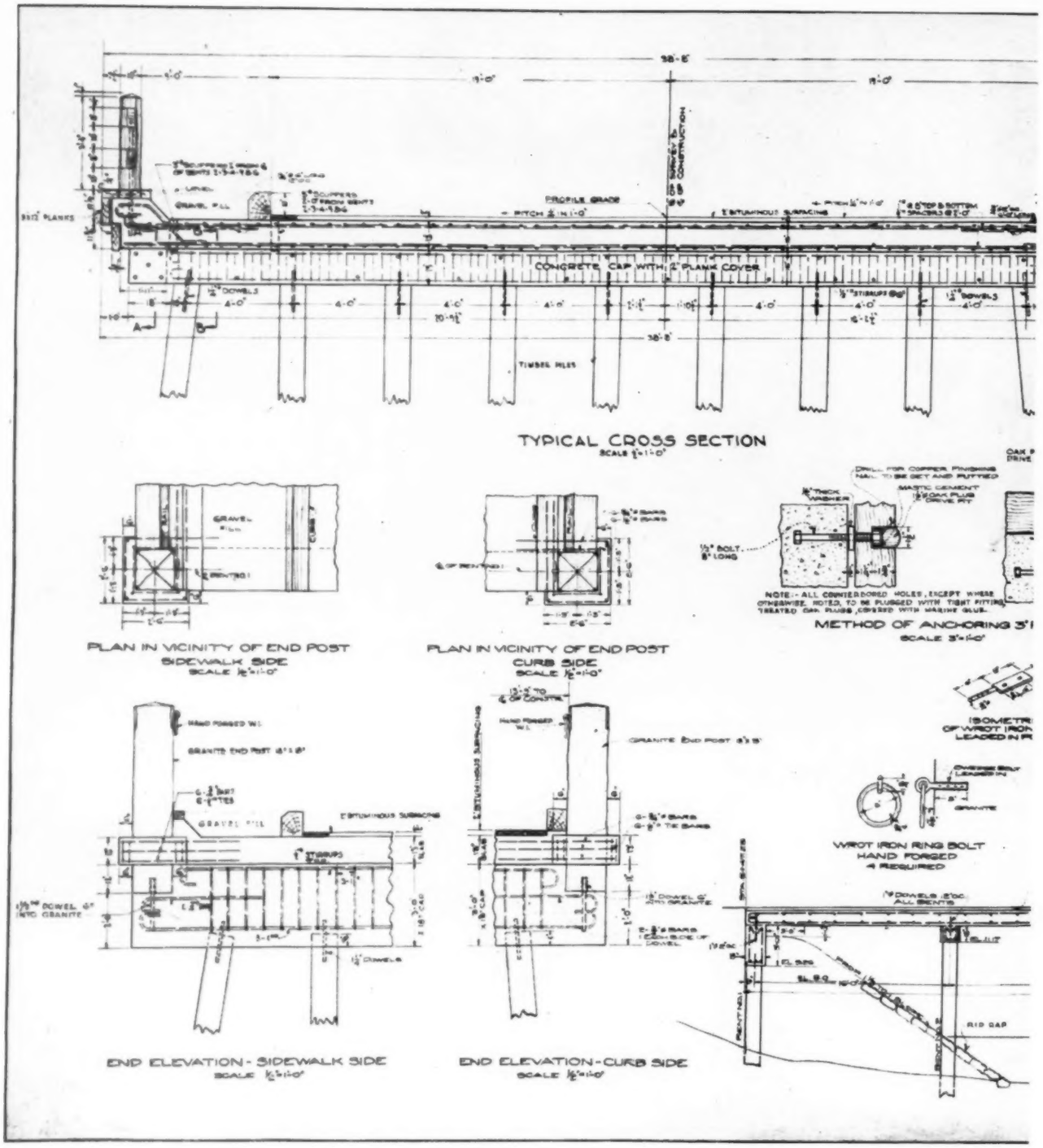

Dover-Sherborn Bridge

spaced 4 ft. on centers, end piles being battered, and were driven through soft, fine, blue sand, some clay, hard fine yellow sand, gravel and boulders to solid rock. There were no problems of river control or traffic.

A 1:2:4 mix of 2,500 lb. concrete was used. The slab is 13 in. thick. Caps are 12 in. by 15 in.

Slab facing is of 3 in. hewn plank on ½ in. washers. Cap facings are of 2 in. plank, rough sawed, applied directtly to the concrete. The cap ends are finished with oak blocks 12 x 15 x 18 in. Posts for the railing are 10 in. square by 3 ft. 5 in. high, and are mounted on 1½ in. round steel bars set in the concrete.

The cost of the bridge exclusive of approaches was $10,350.00, or $3.03 per sq. ft. of roadway and sidewalk. The cost per sq. ft. over all was $2.75. The ornamented features cost $1,430, but as some sort of railing would have been necessary in any case, only a portion of that sum could have been saved by substituting an entirely plain structure. Following are the quantities in the completed bridge:

Bridge excavation	207 cu. yd.
Ledge excavation	10 cu. yd.
Reinforced concrete	177 cu. yd.
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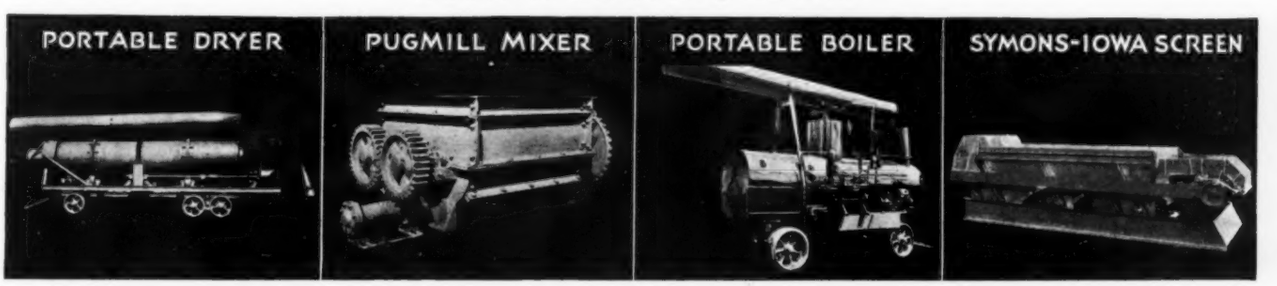
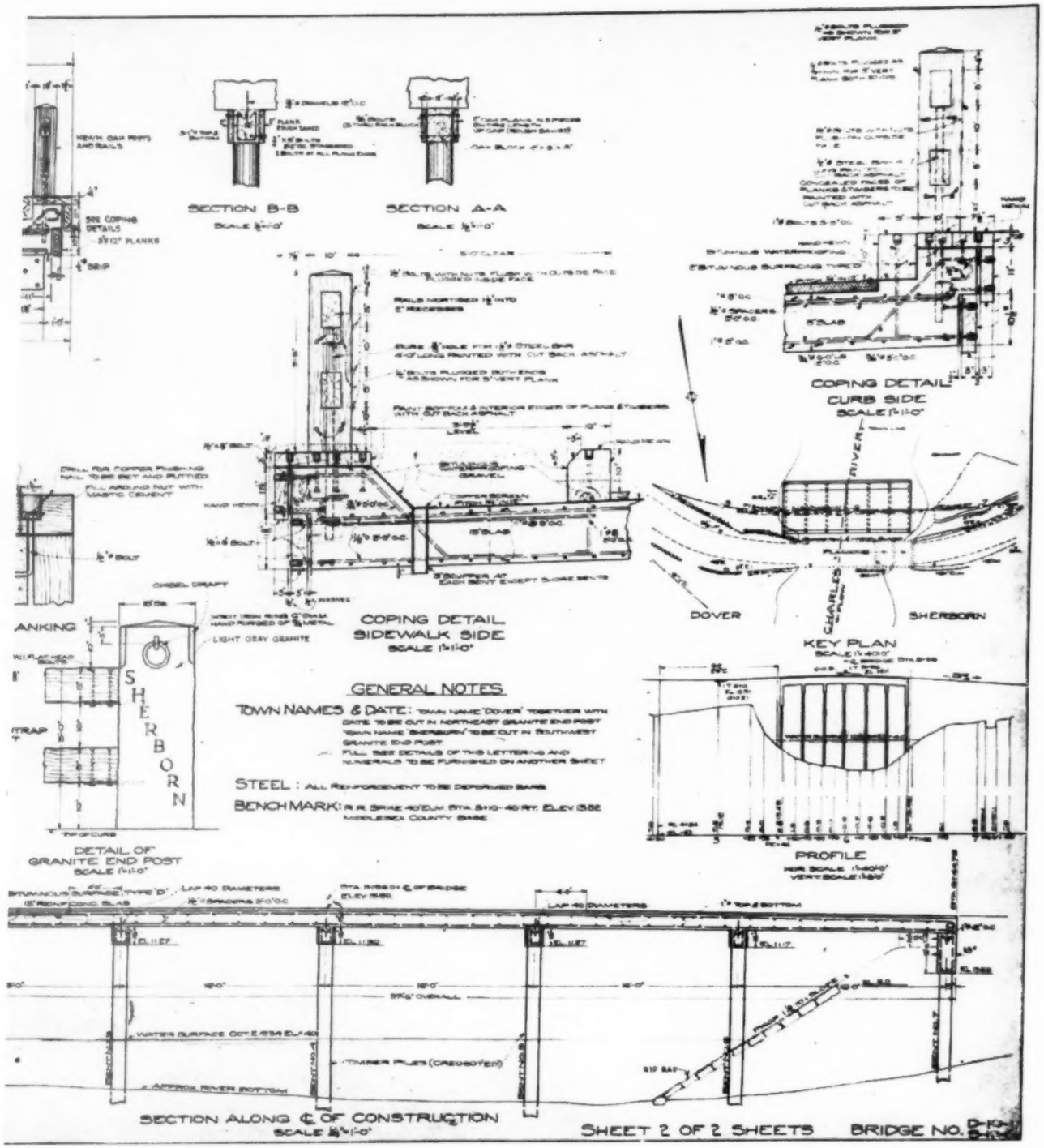
CEDAR RAPIDS, IOWA





Miscellaneous Details

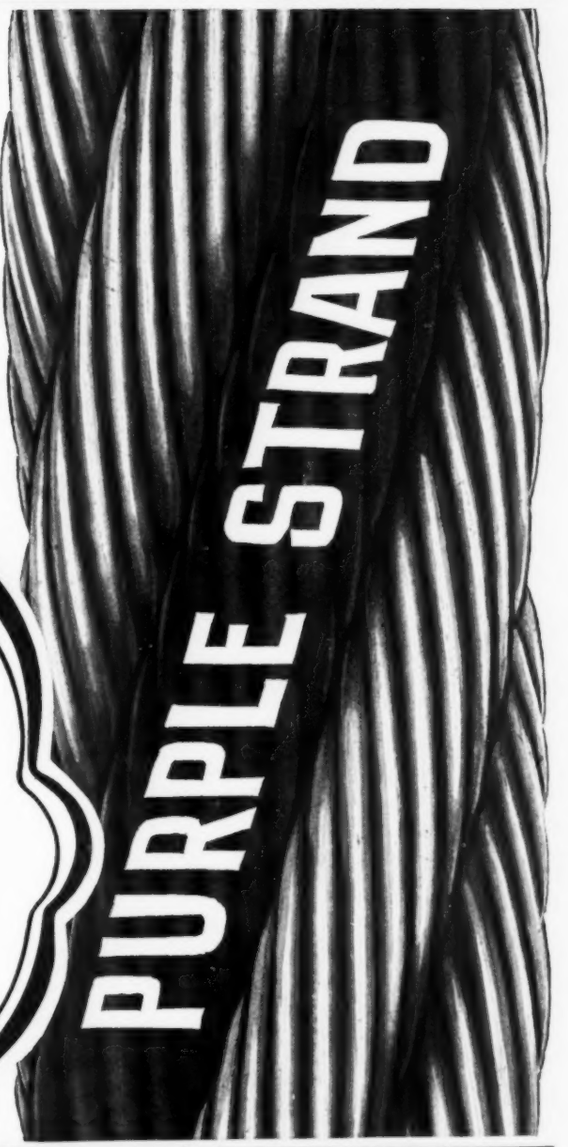
Riprap	108 cu. yd.
Gravel borrow	80 cu. yd.
Creosoted piles	2,856 lin. ft.
Treated red oak lumber	6.75 M. ft. B. M.
Scuppers with screens	10
Reinforced steel	55,000 lb.
Bitum. waterproofing	425 sq. yd.
Granite posts	4
Granite curb	24 lin. ft.
Galv. steel fastenings	1,674 lb.
Removal present bridge	1

The bridge was built by the state of Massachusetts under the direction of William F. Callahan, Commissioner of Public Works; A. W. Dean, Chief Engineer, Department of Public Works. The Lee Construction Company was contractor.

All piling and red oak lumber were supplied by the Century Wood Preserving Co. of Nashma, N. H., and Newport, Del. Steel fastenings were from the American Bolt and Nut Co., Everett, Mass., Kalman Steel Corporation furnished the reinforcement.

STRENGTH

GOOD Wire Rope is an ASSET on any job



Breaking Strength

should be

a very important consideration in the use of Wire Rope.

Here is where Williamsport Purple Strand appeals to nearly every operator who has used it because it has the stamina to give longer and more useful service.

WILLIAMSPORT WIRE ROPE CO.

WILLIAMSPORT, PA. **122 So. Michigan Ave., CHICAGO, ILLINOIS**

Other Offices in All Principal Cities

Fountains Supplied From Subdrainage Systems

By GLEN S. SMITH

Sub-district Maintenance Supt., Indiana State Highway Department.

IN CONSTRUCTING U. S. Route 6 across northwestern Indiana, springs were encountered in a cut a short distance west of State Route 49, north of Valparaiso. Grading operations revealed the springs and the advisability of thoroughly draining this wet cut before paving it in 1928.

Close-up View of Highway Drinking Fountain along U. S. 6 in Northwestern Indiana.

No provision had been made on the plans for this drainage, but an extra work agreement was put through to permit installation of a line of 8-in. Armco perforated pipe. In order to intercept the flow from the springs, a line of this metal subdrain pipe was laid in a trench under the center of the pavement for a distance of several hundred feet and then diagonally cut to the north ditch line at the west end of the cut. The trench was backfilled with gravel.

A similar cut was encountered the following year, near a viaduct over the B. & O. railroad, on the same route a few miles east of State Route 49. Here again an installation of perforated metal pipe under the pavement outletted into the south ditch was successful in stabilizing the subgrade.

One day the writer observed a woman motorist trying to get a drink from the outlet of one of these subdrainage pipes. This led to the idea of building drinking fountains at these two points.

The water was tested and found to be safe for drinking purposes. By plugging the end of the pipe and sealing the perforations for a distance of 10 ft., the water was diverted into a 2-in. water pipe set vertically at the end of the corrugated metal pipe, and then the fountain built around it. There is sufficient head or pressure to operate the fountain at each location.

Roadside planting and beautification has been started at these locations. A graveled backing space on the shoulder has been provided and it is planned to erect suitable signs informing the motorist of "safe drinking water ahead" and inviting him to stop and rest.

For nearly eight years now the perforated pipe has functioned without ceasing. The pavement in these cuts has remained in first class condition in spite of the potentially unstable subgrades.

General View Showing Location of Drinking Fountain Operated by Perforated Pipe Subdrainage System in the Highway Cut in the Background. Note the Graveled Parking Space on the Shoulder.

Removing Asphaltic Concrete Surface With Burners

The resurfacing of sections of Sunset Blvd. in Los Angeles, Calif., required the removal of portions of the old surfacing to permit laying a 1½-in. asphaltic concrete wearing surface. The old pavement consisted of 5-in. Portland cement concrete surfaced with asphaltic concrete varying from 1½ in. to 4 in. in thickness. The old surface was removed by burning, the contractor constructing two large outfits for this purpose. How this work was handled is described by J. M. Lackey, Assistant District Construction Engineer in January California Highways and Public Work.

Each outfit consisted of six burners operated under a 9x15 foot hood mounted on wheels and towed by a two-cylinder road roller, both burners being operated together. A small compressor furnished air to both units. The procedure was as follows:

Grade points were set at from 10 to 20 ft. intervals in the old surfacing and the amount of the cut painted near the point. The burners were then set to work, remaining stationary for from 3 to 5 minutes, depending on the thickness of the surfacing to be removed, then moving about 3 ft.

This operation was followed up with a tractor and grader which windrowed material loosened by the burning for loading into trucks. The surface was then checked, high spots marked and burned with smaller 1-burner units obtained from Los Angeles City.

From 550 to 900 sq. yds. of surfacing were covered by the two large burners per 10-hour day. The area covered depended on the thickness of the old surface to be removed. Kerosene required for 10 hours of burning totaled 400 gals., which, at a cost of 5c per gallon, amounted to from $0.025 to $0.036 per sq. yd. for fuel.

On account of street cars, the burners could not operate within several feet of the rails and a strip 17 ft. wide was burned by direct application of distillate to the surface. In this manner 200 to 300 sq. yds. were burned per day, using about 300 gals. of distillate at a cost of 3½c per gallon, a total of $10.50, or $0.035 to $0.0525 per sq. yd.

PROOF . . .

of PROFITABLE OPERATIONS Le TOURNEAU FLEET USERS

The best testimonial, we believe, to the profitable earth-moving of LE TOURNEAU equipment is the fact that so many successful contractors are LE TOURNEAU fleet users. More than 100 now operate three or more LE TOURNEAU units—and they all started with one on trial. Here are a few of them, selected to show that LE TOURNEAU equipment operates profitably the country over:

American Aggregates Corp.	Piedmont, Ohio
Guy F. Atkinson	San Francisco, Calif.
Bechtel-Kaiser Co., Ltd.	San Francisco, Calif.
Border Electric & Telephone Co.	Tijuana, Mexico
W. E. Callahan Construction Co.	Yuma, Arizona
L. Coluccio & Co.	Seattle, Washington
Louis Davis Construction Corp.	Seaford, L. I.
Dunn & Baker	Klamath Falls, Ore.
S. E. Evans	Van Buren, Arkansas
Benjamin Foster Co.	Philadelphia, Pa.
Grace Bros.	Honolulu Ter., Hawaii
Green River Lumber Co.	Green River, Wyoming
S. J. Groves & Sons Co.	Gardner, Montana
C. V. Hallenbeck	Denver, Colorado
Isbell Construction Co.	Reno, Nevada
Peter Kiewit Sons Co.	Omaha, Nebraska
Jan Le Can	Bordeaux, France
Lewis County	Washington
Lewis & Frisinger	Ann Arbor, Mich.
John Mowlem & Co., Ltd.	London, England
W. H. Noel Company	Carpio, N. D.
John Oman, Jr.	Nashville, Tenn.
B. Perini & Sons	Framingham, Mass.
Setauket Contracting Co.	Long Island, N. Y.
Six Companies, Inc.	Boulder City, Nev.
Tennessee Valley Authority	Iuka, Miss.
Winston Bros.	Minneapolis, Minn.

The experience of these users proves that LE TOURNEAU equipment moves more yardage quicker and at less cost. Talk to them; they are our best salesmen. Visit their jobs; see for yourself what LE TOURNEAU equipment is doing.

R. G. Le TOURNEAU INC.

Peoria, Illinois Stockton, California

Cable Address: "Bobletorno"

ANGLEDOZERS—BULLDOZERS—BUGGIES—CARRYALL SCRAPERS — CRANES — ROOTERS — SHEEP'S FOOT ROLLERS—POWER CONTROL UNITS—TRAILERS

LE TOURNEAU Sheep's Foot Rollers working in tandem—part of a LE TOURNEAU fleet owned by Payton Brothers of San Francisco, California.

Lane Construction Company, New England, owner of nine LE TOURNEAU CARRYALLS, cuts operating costs by working his CARRYALLS in tandem hookups.

Three of Chas. Weaver's LE TOURNEAU CARRYALL fleet moving earth on a Mississippi Highway job.

Two of seven LE TOURNEAU CARRYALLS at work for Edward H. Ellis, Inc., on the Chesapeake-Delaware Canal.

LE TOURNEAU

NEW EQUIPMENT AND MATERIALS

New Le Tourneau 24-yd. Carryall Scraper.

New 24-Yd. Carryall Scraper

A 24-yd. carryall scraper for use with large-size tractors is now being manufactured by R. G. Le Tourneau, Inc., of Peoria, Ill., and Stockton, Calif. The new unit was first shown at the Cleveland Road Show where it attracted a great deal of attention.

This carryall is a telescopic scraper with a capacity of 24-yds. loose measure. The body proper consists of five buckets, one within the other. As the buckets fill, they are pulled back from the cutting edge by one line from a Le Tourneau four-drum power control unit until they form one long, evenly-filled bucket. Thus, it is stated, the dirt is always loaded into an empty bowl with no tractor power being expended for pushing material up through dead earth. It dumps and spreads with the same ease and accuracy that characterizes the Le Tourneau 12-yd. carryall.

Tires for the new unit are 18.00x24, mounted in four dual sets.

▼

New Line of Jaeger Mixers

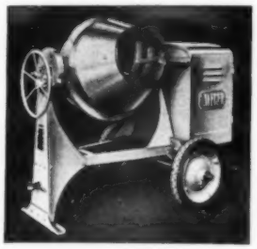
Faster charging and discharge speeds; smoother operation due to machined steel drum tracks with ball bearing rollers and an average of 25 per cent more engine power; plus modern, compact, streamlined designs, including 2-wheel pneumatic tire mounting for 3½S, 7S and 10S mixers, are features announced by the Jaeger Machine Co., in its 1936 line of concrete mixers.

New Pneumatic Tired Speed King Model.

For bridge building, curb and gutter and general construction work, the manufacturer stresses the advantages of its 2-wheel 10S and 7S Speed King models of the type pictured here, because of their end discharge design and ease of hauling and of placing on the job. Heavy 6- and 8-ply industrial pneumatic tires are used. Pneumatics, with Timken bearing axle, make it possible to trail these Speed Kings behind light trucks at speeds up to 35 miles an hour, it is stated.

Streamlined tilting mixers are offered in 3½S to 7S sizes, featuring the Jaeger patented "Dual Mix" drum with "V" bottom on all models, a pneumatic tired 3½S trailer, and a popular priced 5S size with 2-wheel trailer mounting and end discharge adapted for work in congested streets, backing up to cellar windows and foundations, and pouring with swinging spout.

Jaeger non-tilting units are being built in 7S to 56S sizes with machined steel drum track standard on all sizes. Skip shaker power loaders and gate-type shaker batch hoppers, with wider, special shape discharge chutes and "forced discharge" bucket action make possible higher speeds and increased production in spite of the dry, sticky mixes used today. To combat abrasive action of harsh concrete and lengthen life of the mixers, man-ten steel is used in renewable liners and at points of greatest wear.



New Small Filter.

In its 1- and 2-yd. plant mixers, the company states that it has achieved the shortest, most compact design yet produced for advantageous set-up with operating speeds comparable to that of smaller Jaeger mixers. A new catalog, giving complete details of this 1936 line, including plaster-mortar and cold patch mixers, concrete buckets and a new type of pneumatic tired concrete buggy, may be obtained by writing to the Jaeger Machine Company, Columbus, O.

▼

New Street Striper

A new street striper which lays down the stripe by means of a rotary printing action has been placed on the market by the Lewis Manufacturing Co., Decatur, Ill. The rotary printing effect is attained by using a soft (but tough) pure rubber flexible wheel as shown in the illustration. The flexibleness of this wheel is stated to assure a perfect, intimate contact with the pavement at all points throughout its full width, even though the pavement is uneven.

The Lewis Striper.

The paint or lacquer is drawn from the container by means of a positive action gear pump. This pump forces under slight but definite pressure, the paint or lacquer onto the corrugated face of the flexible rubber wheel that lays the stripe on the pavement. This paint passes onto the face of the wheel through a specially designed nozzle that insures even distribution of the paint or lacquer across the entire face of the wheel. The pump is positive in action and geared to supply the right amount of paint or lacquer, whether the operator walks fast or slow. The entire action is a rolling action, making the Lewis striper easy to push.

The dimensions are: Width, 14 ins.; length, 36 ins.; weight crated ready for shipment, 88 lbs.; height to top of handle, 30 ins.

▼

New Hug 12-Yd. Hauling Unit

The Hug Co., Highland, Ill., has announced a new Model 95 6-wheel Hug lugger. In designing the Model 95 lugger, Hug engineers have combined the chassis, body and hoist into an integral 12-yd. hauling unit, by covering two rear driving axles, ordinarily used under a 6-yd. truck, into a front and rear axle drive, and adding a 6-ton trailer axle as a center axle. Sufficient carrying capacity has been built into this truck to justify the installation of a Caterpillar Diesel engine.

Both front and rear axles are driving axles and are of the double reduction, full floating type, with high traction differen-

CONCRETE

has every engineering advantage a pavement can have *plus*

UNIVERSAL PUBLIC PREFERENCE

The Concrete Pavement Library now consists of:

"Concrete Road Design Simplified and Correlated with Traffic" by Frank T. Sheets, for 9 years Chief Highway Engineer of Illinois.

"Short Count Traffic Surveys" by Dr. Miller McClintock, nationally known traffic expert, and director of the Erskine Traffic Bureau of Harvard University.

"What Old Concrete Roads Tell Us" as revealed by a condition survey of 6,000 miles of representative concrete pavements in service in ten states.

"Concrete Pavement Manual" brought up to date . . . 72 pages of specific, practical information on how to design and build better and more economical concrete pavements.

WHEN you build a concrete highway, you never have to explain why you used concrete! Motorists know that concrete is swift but safe, smooth but non-skid, visible at night . . . and saving in gas, tires and car repairs.

When Public Preference is in full accord with highest engineering practice, there would seem to be but little basis for consideration of anything other than enduring, low-cost concrete whenever public money is invested in public roads. For it is now certain that concrete is actually lower in first cost than any other pavement of equal load-carrying capacity.

Concrete is the most *adaptable* of highway materials. The designer can vary the slab thickness to suit traffic loads. Thus, the secondary highway can, with fullest confidence of long life, be of lighter and more economical cross-section than the main-traveled primary highway.

PORTLAND CEMENT ASSOCIATION

Dept. A3-28, 33 West Grand Ave., Chicago, Ill.

tial. Four large tires of 18-in. cross section by 61-in. outside diameter and two smaller tires of 12-in. cross section and 48-in. outside diameter give a total ground contact of 2,400 sq. ins., assuring positive traction.

A unique Hug principle in design is the addition of the center steering axle. This axle, mounted between the driving axles, serves not only as a load carrying member, but by steering in tandem with the front driving axle combines great load carrying capacity with exceptionally short turning radius. Both front and center axle steering is air actuated for ease of handling.

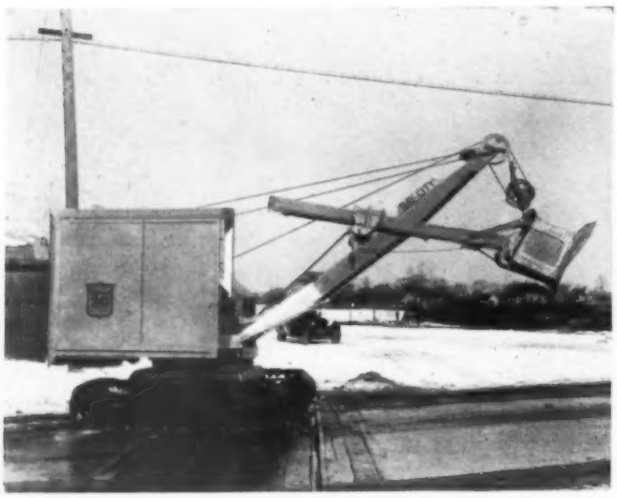
The Model 95 Hug lugger is available with the new 12-yd. Hug "scoop end" body, rigidly reinforced with "U" shaped "I" beam steel ribs. It is also equipped with a 12-yd. specially designed Le Tourneau "slide-out" body. The latter type of body eliminates the use of a power hoist, the four sides of the body sliding back off the bed, forcing the load to travel with it and leaving an ever widening opening until the body has reached the extreme rear position.

Proper load distribution and location of axles, together with the Caterpillar Diesel installation, gives this Hug lugger unit the same flexibility and ease of handling as the smaller 5 and 6-yd. Hug roadbuilders.

▼

New Bay City ⅜-Yd. Shovel

A new model full-revolving combination shovel, dragline, clamshell, crane or truck hoe has been brought out by Bay City Shovels, Inc., Bay City, Mich. The new model 20 has a full ⅜ yd. bucket capacity and can handle safe 4-ton crane loads. Some of the features of this new model are: Compact design—



New Bay City Model 20

yet plenty of elbow room. Elimination of useless "dead weight" by alloy steels and heat treating. Anti-friction bearings. Chain crowd, positive and independent. Drop forged crawler shoes (14 in. wide), long wearing life. Unit cast car body and machinery table of nickel-manganese steel, totally heat treated. Six cylinder gasoline or diesel power—"E-Z" clutch control. Cut helical gears on all drum shafts—helical gear drive, in oil. Safety worm boom hoist—positive spring lock—cab in any position. Positive propelling lock—all controls from operator's seat.

The model is built with sturdy chain crowd, split sticks and heavy box type electric welded boom. Sticks are of heavy tubular construction, ship channel and welded plate, with manganese crowd rack, in sections, bolted and spot welded in place. The crowd chain is automatically adjusted through the patented chain tension device. This device compensates for variations in chain length according to boom angle. It also absorbs part of the shock of crowding. It is not necessary to disconnect or adjust crowd chain when making extreme variations in boom operating angle. Boom can be hoisted from level position (as in shipment on car) to its highest lift position without bothering to adjust, or add or remove links from crowd chain.

New Hoist for Dump Bodies

A new direct lift, double-acting hoist for 1½ to 2-ton trucks, that provides a 77 degree dumping angle, has been brought out by the St. Paul Hydraulic Hoist Co., St. Paul, Minn. The hoist is a heavy duty type with full 6 in. cylinder bore and massive hinge construction, with heavily reinforced frame.

St. Paul Hi-Dumper Hoist Mounted with St. Paul Mucker Body

After a loaded body reaches a 50 degree dumping angle, the center of gravity of the load passes beyond the center of the hinge. The hoist is equipped with a hydraulic check, which cushions the load to the extreme dumping angle, controlling the speed of the body throughout the entire dumping operation, thus eliminating shock to the hoist and chassis frame.

No springs or chains are necessary to return the body to normal position. By placing the valve in the lowering position and engaging the power take-off, the body will be brought back by hydraulic power. For quick action, the body may be lowered the entire distance by power, or merely brought back past the center of gravity from which point it will return by gravity.

With the new hoist, the body can be locked in any position even after passing the center of gravity. The pump may be left in operation when spreading a load, and the body may be raised, lowered, or locked at will. The control valve on the hoist provides positive control at all times.

▼

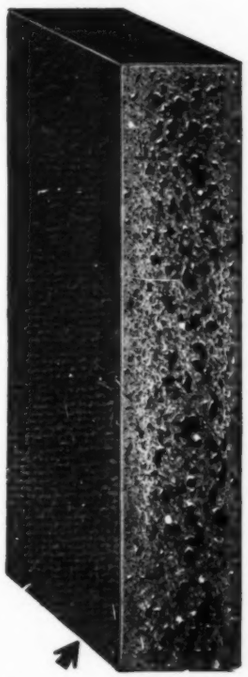
New Portable Crushing and Screening Plant

One of the outstanding features of the new portable crushing and screening plant of the Diamond Iron Works, Inc., Minneapolis, Minn., is the device used for transferring the crushed stone or gravel. This is known as the "Rotor-Lift," and it is actually a large size saucer (7½ ft. in diameter), with an opening through the center for the field conveyor. The product from both the primary jaw crusher and the secondary roll crusher is delivered to the lower side of the rotor, which rescreen is suspended in rubber in shear, which eliminates any volves slowly, dropping the material on the field conveyor. The advantage claimed for this device is that the bucket elevator

The New Portable Crushing and Screening Plant of the Diamond Iron Works

is entirely eliminated, and it is not necessary to use long conveyors, thus permitting a shorter plant.

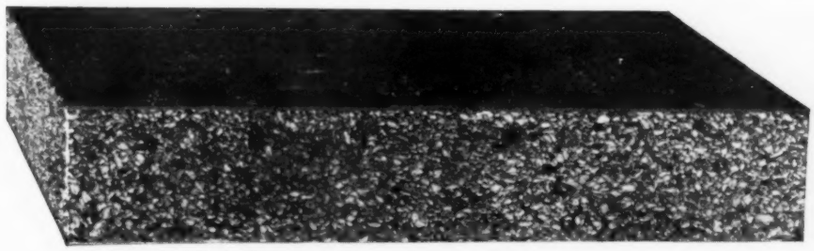
Another exclusive feature in the machine is that the vibrator vibration from the screen being transmitted to the plant. The entire plant is equipped with anti-friction bearings throughout.



Sponge Rubber Joint—compressed to 50% thickness—the extrusion .50—recovery one hour 90-95% Felt or Mastic sides.

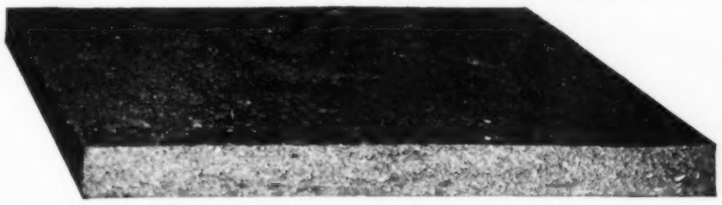
Servicised
EXPANSION JOINTS

Premoulded Cork Joint

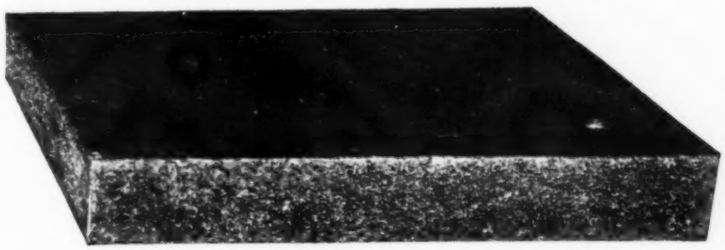


Premoulded Cork Joint—compressed to 50% thickness—the extrusion .25—recovery 90-95%.

Felt Sided Asphalt Joint—compressed to 66% thickness—the extrusion .50—recovery one hour 68%—contains 70% Asphalt. Furnished with or without metal escapes or seals.



Cork Fiber Joint—compressed to 64% thickness—the extrusion .42—recovery one hour 71%—contains 38% Asphalt. Furnished with or without metal escapes or seals.



Fiber Joint—compressed to 50% thickness—the extrusion practically nil—recovery one hour 70-75%.

Type B Asphalt Joint—compressed to 66% thickness—the extrusion .42—recovery one hour 70%—contains 65% Asphalt. Furnished with or without metal escapes or seals.

THE above types of joint illustrate SERVICISED service to engineers and contractors in providing both the controlled oozing and non-oozing types of expansion joint. The specifications of the various types are shown under each type and are the minimum and not the maximum tests.

Our types of non-oozing joints will not warp or shrink in the hot sun or hot weather eliminating the necessity of wetting down before using.

The oozing types of joint are controlled by metal escape accessories making provision for the surplus flow under pressure. We also furnish engineers extruded joints for the reception of metal fittings and specialize on extruded products for engineers in State, Municipal, Railroad and Civil work.

SERVICISED service and performance have never been questioned and the same quality is being maintained as heretofore.

SERVICISED QUALITY PRODUCTS © 1936

SERVICISED PRODUCTS CORP. ● 6051 W. 65th ST. ● CHICAGO

The bearings used in the conveyors are a recent development of the New Departure Manufacturing Co., wherein the lubricant is sealed in the bearings at the factory, and the conveyors do not require any further lubrication throughout the life of the plant.

The plant is equipped with a 10 in. x 36 in. Diamond roller bearing crusher, a secondary 30 in. x 20 in. roller bearing roll crusher, a 4 ft. x 8 ft. special vibrator screen equipped with 2½ in. decks. Greater screening area is provided in the plant by a unique arrangement of the different decks, which assures proper screening with unusually large capacity.

Ross Traffic Markers

A new type of highway marking recently developed is claimed to solve many problems of adequately marking highways, definitely giving the driver of an automobile a dividing line on the roadway and ample warning of a danger spot ahead.

The marker, placed on the road 350 to 400 ft. in advance of the curve or other dangerous condition allows the driver to bring his car under control without jamming his brakes, locking his wheels with the result of the car being entirely out of control. They are claimed to be especially efficient at night as the reflector

Ross Traffic Markers on a Curve

buttons are visible 500 to 600 ft. ahead, resulting in the curve being clearly outlined, as illustrated herewith. The motorist sees ahead a string of what appears to be electric lights down the center of the highway, a warning in advance, also indication of the radius of the curve to be encountered.

The marker itself, a very ingenious device, patented by David E. Ross of Purdue University, consists of a non-corrosive metal housing hardened to withstand traffic and so designed that they present no hazard to vehicles passing over them. The lenses placed at each end of the casting are amply protested against breakage through impact of the wheels of vehicles. They are held in place by a ⅞ in. by 2 in. lead expansion anchor with a ½ in. by 2 in. cut thread cadmium plated cap screw, thus lenses, if damaged are easily replaced with virtually no cost.

The Highway Traffic Control Co., Inc., 39 Cortlandt St., New York City, is Eastern Distributor for the Ross Markers.

New Truck-Tractor and Semi-Trailer Dump Wagon

A feature of the recent Cleveland Road Show as well as the Purdue, Ind., Road Show, particularly from the standpoint of the contractor, was a combination of a new Marmon-Herrington all-wheel-drive Ford V-8 truck-tractor and a new Insley semi-trailer dump wagon which were shown as a complete unit.

The complete unit, including both tractor and semi-trailer, weighs slightly more than 8,500 lbs. and is stated to be capable of hauling a gross load of approximately 25,000 lbs. Although the overall length of the entire unit is 26 ft., 9 ins., it has a minimum turning radius of only 28 ft., 3 ins. The capacity of the Insley semi-trailer is 5 cu. yds. and it has an overall width of 86 ins.

The tractor is equipped with 32 x 6 in., 10-ply tires on both

Front View of the Complete Unit.

front and dual rear wheels while the dual rear wheels of the semi-trailer have 32 x 6 in., 8-ply tires. Other tire sizes are available.

The semi-trailer has drop-bottom doors and these are controlled from the cab by means of a clutch release and power wind-up.

The tractor used in the unit is a standard 1936 Marmon-Herrington all-wheel-drive Ford V-8, Model B5-4 x 4 with a wheelbase of 132 ins. Driving front axle, two-speed auxiliary transmission and other all-wheel-drive parts are built into the truck by Marmon-Herrington engineers in the Marmon-Herrington factory, making it a genuine all-wheel-drive from every standpoint. The semi-trailer is the Insley Model No. 74, only recently developed and placed on the market.

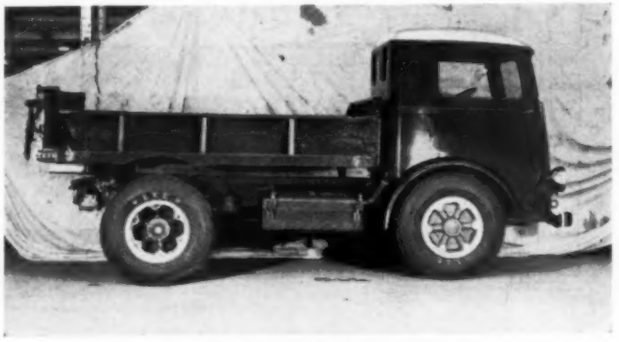
Factories and general offices of both the Marmon-Herrington Co., Inc., and the Insley Manufacturing Corporation are in Indianapolis, Ind.

New Mack Traffic Type Trucks

Two new traffic type models, lighter in capacity than the traffic type Macks heretofore available are announced by Mack Trucks, Inc., 25 Broadway, New York. Known as the EC and EB, the new trucks are corresponding models respectively to the conventional Mack Models BG and BF. In design and appearance they adhere closely to the present Mack Traffic Type Models CH and CJ, which have been in production for over two years. Through their condensed forward construction, the new models in each case save 3 ft. in length over the corresponding models, besides providing one-third, two-thirds gross weight distribution.

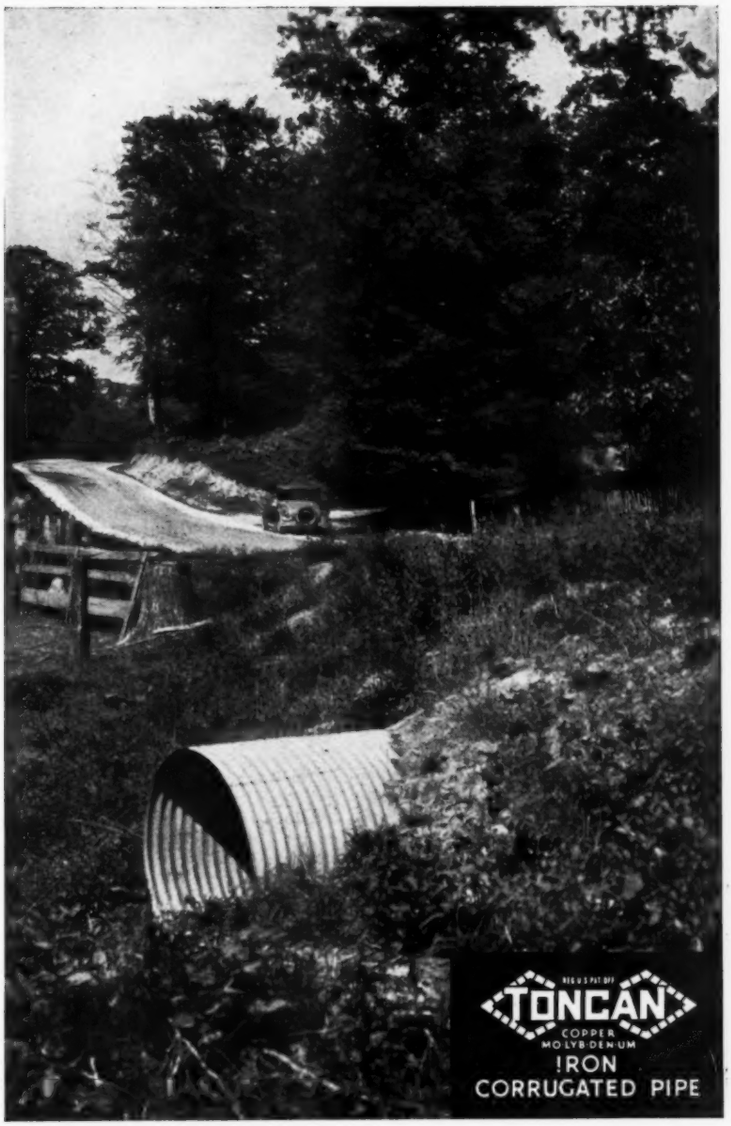
Located between the floorboard and the seats, the engine is covered by a double-shell housing of aluminum heavily insulated on the inside, and seating in a felt-filled channel, being thus heat-tight, sound-proof and gas-proof. This enclosure is in two parts, both of which are easily removable.

Both the new models are powered by time-proven 6-cylinder Mack engines, that in the EC having a 3⅝ by 5 bore and stroke and developing 79 horsepower at a governed speed of 2,300 r.p.m., while the 3⅞ by 5 EB engine produces 92 horsepower at the same governed speed. Identical in general design, they are of the L-head type with block-cast cylinders and a deep-section integral crankcase of heat-treated chrome-nickel.



Side View of Mack Model EB Traffic Type Truck.

A ROAD IS NO BETTER THAN ITS DRAINAGE



Corrugated Iron Culverts have solved many drainage problems; they are recognized by leading engineers and highway officials everywhere, as sound drainage structures. When buying corrugated pipe, specify TONCAN, the pipe made of Open Hearth Iron, alloyed with Copper and Molybdenum; it will give years of low cost, dependable drainage service.

TONCAN CULVERT MANUFACTURERS' ASSOCIATION

REPUBLIC BUILDING, CLEVELAND, OHIO

Beall Pipe & Tank Corp. . . Portland, Oregon
Berger Metal Culvert Co. of N. E., Boston, Mass.
Bluegrass Pipe & Culvert Co. . . Louisville, Ky.
Central Culvert Company . . Alexandria, La.
Dominion Metal & Culvert Corp., Roanoke, Va.
Eastern Culvert Corp. . . . . Philadelphia, Pa.
A. N. Eaton Metal Products . Omaha, Nebraska
A. N. Eaton Metal Products Co., Billings, Mont.
Eaton Culvert Co. . . Grand Island, Nebraska
Empire State Culvert Corporation, Groton, N. Y.
Illinois Corrugated Culvert Co. . . Peoria, Ill.
Jensen Bridge and Supply Co. . Sandusky, Mich.
H. V. Johnston Culvert Co., Minneapolis, Minn.
H. V. Johnston Culvert Co. . . Aberdeen, S. D.
Wm. E. Newman & Sons Co. . . Ogden, Utah
Republic Steel Corporation, Canton Culvert Division . . . . . Canton, Ohio
Thompson Mfg. Co. . . . Denver, Colorado
Tri-State Culvert Mfg. Co. . . . . Memphis, Tenn., Atlanta, Ga.
Truscon Steel Co., Indiana Culvert Division . . . . . Indianapolis, Indiana
Western Pipe & Steel Co. . . . Los Angeles and San Francisco, Calif.
Wisconsin Culvert Co. . . . . Madison, Wis.
Wyatt Metal & Boiler Works . . . . . Houston and Dallas, Texas

TONCAN IRON ✣ A PRODUCT OF REPUBLIC STEEL CORPORATION

Frames are of chrome-manganese, heat-treated pressed steel, braced by staunch tubular and channel cross-members, and fastened permanently by hot-riveting through jig-drilled and reamed holes confined to the webs of the main rails, to provide maximum rigidity and resistance to fatigue. On the EC the frame dimensions are 8 7/16 in. by 3 in. by 7/32 in., while the EB frame is 8½ in. by 3 in. by ¼ in.

New Front-End Power Control Unit

A front-end power control unit, designed particularly for users who want a power unit that will operate angledozers or bulldozers, yet leave the rear of the tractor free for mounting logging winches or other similar equipment, is now being manufactured by R. G. Le Tourneau, Inc., Peoria, Ill., and Stockton, Calif.

The new power control unit, compactly built, is mounted at the front of the tractor and takes its power direct from the motor crank shaft through gears. Like all Le Tourneau equipment, it

Le Tourneau Front-End Power Control Unit.

is operated from the tractor seat by means of a convenient lever.

The entire unit is stoutly constructed by electric arc welding of special alloy steel. No castings are used in any part of it. Timken and Hyatt bearings assure fast, free-running operation and the same trigger-quick action that characterizes the standard Le Tourneau power cotnrol unit.

Surface Heater

The new improved surface heater of the Equitable Asphalt Maintenance Co., Kansas City, Mo., has the heater unit mounted on a 2-ton heavy duty Diamond T truck chassis built for power at low speed. The overall length of the entire machine is 27 ft., 8 ft. wide and 7 ft. high.

The surface heating hood is 8 ft. by 8 ft. square and is made of heavy steel plate with skids, connecting rods and lifting cable. This hood is attached to the rear of the machine and is so arranged that when in operation will slide forward or backward on the street surface without the necessity of raising. Raising this hood is necessary only when the machine is to be turned around or when traveling from one location to another.

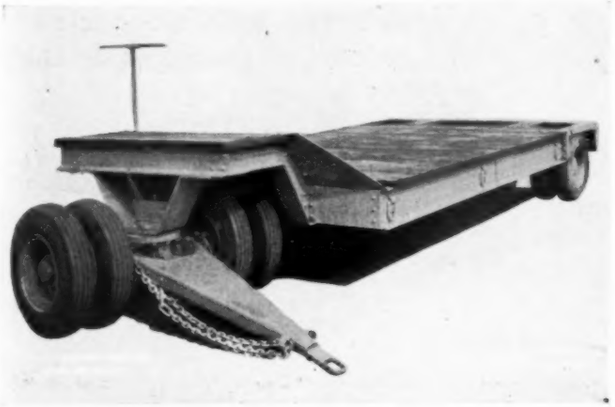
A heavy duty hydraulic hoist completely enclosed in the machine is used to raise and lower the hood. All operating parts are completely enclosed in the machine frame with easily operated sliding doors on both sides which can be locked. The machine is equipped with a Garden City blower operated with a 12 h.p. Nova engine. The Equitable surface heater is equipped with a specially designed oil burner. The oil is drawn into the burner under pressure and properly mixed with air. As the oil reaches the burner outlet it spreads fan-like into the hood as fine vapor. The heat from this burner is deflected by the hood to the pavement. The fuel oil tank has a capacity of 200 gals., and is made of 14 gauge steel. This tank is mounted upon the steel frame directly over the machine and is provided with suitable valves and pipe connections to a rotary chain driven pump which is used to fill the tank.

Equitable Surface Heater on Job in Kansas City

Two New Heavy-Duty La Crosse Machinery Trailers

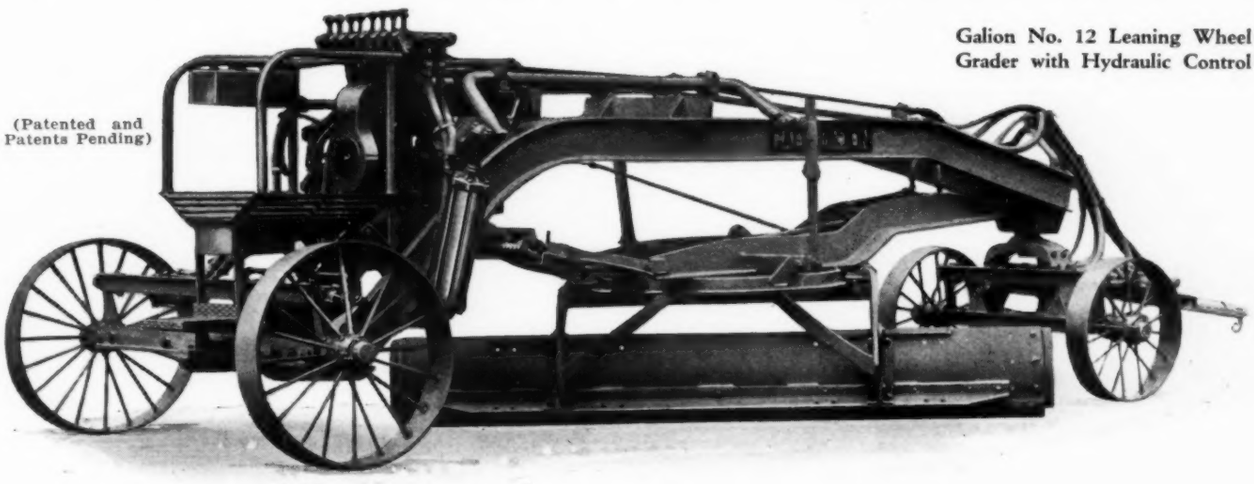
The C. R. Jahn Co., La Crosse, Wis., announces two additions to their line of La Crosse machinery trailers for transporting shovels, tractors, road-rollers, and other contracting equipment. One is a 4-wheel trailer designed for loads up to 12 tons, and the other, with six wheels, is designed for loads up to 18 tons. In both the new models, the main beams extend the full length of the trailer and are shaped without cutting top or bottom flanges at the front deck. The front deck is raised to clear the front wheels to permit a full right angle turn of the front axle. The frame is further strengthened by tie plates at each of the numerous cross members.

The 4-wheel trailer has a rigid mounted rear axle; while the 6-wheel type has two independent oscillating type axles that are



Two Views of the Model KU, 6-Wheel La Crosse Machinery Trailer. The 4-Wheel Model Is Similar in Construction.

You Can Buy with Confidence



Galion No. 12 Leaning Wheel Grader with Hydraulic Control

(Patented and Patents Pending)

In anticipation of your confidence in selecting Galion Leaning Wheel Graders, you may rest assured that—

When you purchase a Galion Grader you know that with it come the benefits of nearly thirty years' experience in designing and building Road Machinery.

This invaluable experience, which guides the recommendations of Galion Engineers is your assurance of getting a Grader of the proper size and weight to exactly do the job you want it to do.

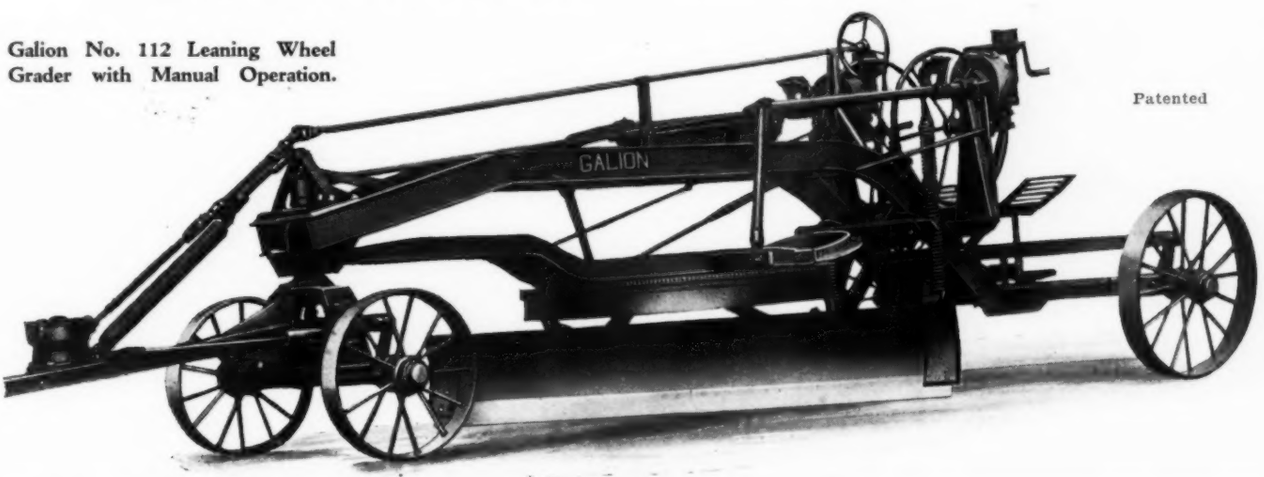
Only sound practical design is accepted, after exhaustive tests and long trial periods have proven its worth.

Galion Graders have a host of advantages . . the most modern designs . . that you would expect to find in higher priced machines.

Galion Engineers have studied your problems . . they know Road Machinery . . and they build for YOU.

Make a comparison . . see how much more Galion gives you for your money. You can buy a Galion Grader with confidence. Send for data.

Galion No. 112 Leaning Wheel Grader with Manual Operation.



Patented

The Galion Iron Works & Mfg. Co.

Galion **Ohio**

Rollers - Graders - Spreaders - Drags - Rooters

so arranged that the four wheels adjust themselves to the irregularities of the road. With this construction, each wheel carries its share of the load at all times.

Both models feature the oscillating front axle, another of the exclusive developments in La Crosse trailers. This arrangement eliminates the necessity of front springs and provides greater flexibility and ease in turning.

The brakes are of the mechanical, internal expanding type and are available for vacuum or air operation.

Over-sized taper roller bearings are used throughout. The loading height of each trailer is only 29 ins.

The trailer width of 8 ft. conforms with the highway regulations of all states. Solid or pneumatic tires are furnished on specification.

Self-Expanding Joint for Concrete Pavement

The accompanying illustration shows a technician in the Johns-Manville Research Laboratories Measuring the Thickness of a Sample of New J-M Self-Expanding Cork Expansion Joint after It Has Been Expanded by Exposure to Moisture. The Sample on the Right Is the Same Product in Its Pre-Compressed State. Note the Difference in Thickness.

Known as SE (self expanding) cork expansion joint, this new product is a development by the Johns-Manville Research Laboratories of the standard J-M cork expansion joint which has been widely used in concrete construction—both in roads and in buildings — for several years.

In making SE joint the material is first fabricated into the standard joint material. Then the moisture is removed and the cork compressed to approximately 60 per cent of its original thickness. To hold this SE joint in its compressed state it is necessary only to prevent re-absorption of moisture, so immediately after compression it is wrapped in a special water-resistant package which is not removed until just before installation.

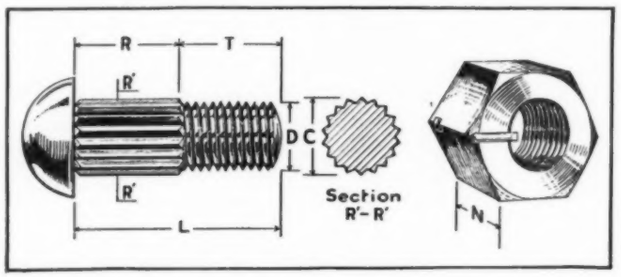
Diesel Power Now Standard on P&H Shovel Line

Announcement is made by the Harnischfeger Corporation of Milwaukee that Diesel power has been adopted as standard equipment on their entire line of excavators ranging from ⅝ to 4 cu. yd. capacity. The only exceptions are found in the P&H Ward-Leonard electric machines of from 2 to 4 yd. in capacity and the smaller bantam-weights, ⅜ and ½ yd., powered by a Ford V-8 motor. Diesel may also be had on the bantam-weights if desired. Gasoline power will be available for the excavators, if desired. This announcement comes simultaneously with that of the new P&H "Pacemakers," a completely redesigned line of excavators which take advantage of two of the most recent developments in mechanical engineering; namely, the use of new high tensile alloy steels and arc welded construction. All excess weight has been stripped off to make them lighter and stronger. P&H design adapts these machines particularly well with heavier crowd and swing mechanisms to stand the higher degree of sustained power of the Deisel engine and give them the "follow through" that prevents motor stalling under the most severe digging conditions.

The first of this new series of machines, the Model 765, was exhibited at the 1936 Road Show in Cleveland in January.

Structural Rib Bolt

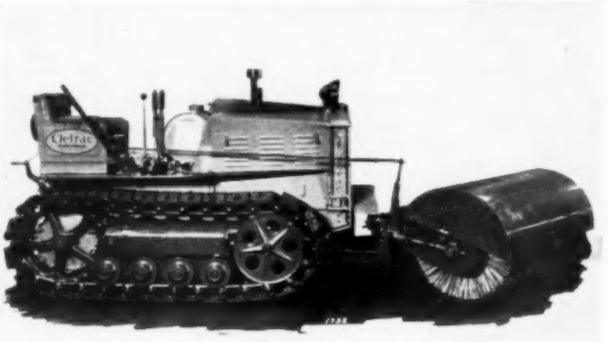
A structural rib bolt that when used with a special nut lock claimed to be a practical substitute for riveting has been placed on the market by the Automatic Nut Co., Inc., Lebanon, Pa. The bolt is used with a nut lock, known as the Anco. The rib bolt and the Anco-Nut both have U. S. standard threads and can be galvanized without affecting the locking feature. The only equipment necessary for installing the bolt is a hand hammer and wrench. The rib bolt is driven through the hole and the nut drawn tight with the wrench. It is stated the Anco-nuts can be removed with an ordinary wrench as easily as an ordinary nut by merely exerting sufficient pressure. This moves the locking pin automatically to a slightly different angle and removes the ratchet of the pin, thus permitting the anco-nut to be loosened or removed. It cannot be unlocked without using a wrench. The anco-nuts can be put on or taken off repeatedly without damage to pin, threads, nut or bolt.



Structural Rib Bolt. The Diameter of the Rib Section "C" is 3/32 in. Greater Than the Nominal Diameter of the Structural Bolt "D," and 1/32 in. Larger Than the Size of the Hole-Size in the Work

Sidewalk Snow Cleaner

The illustration shows the Model EN Cletrac of The Cleveland Tractor Co., Cleveland, O., equipped with revolving broom manufactured by the Detroit Harvester Co. The tractor is 42 ins. wide overall, and the broom has a sweeping width of 42 ins. This narrow width permits the operation of this unit in close quarters, where wider equipment could not operate. It is claimed this equipment is particularly valuable during the winter months in cleaning snow from sidewalks, streets, railroad crossings or station platforms. It is equally effective in sweeping dirt or refuse from factories, locomotive yards, car shops, warehouses, freight terminals, garages or stock yards.

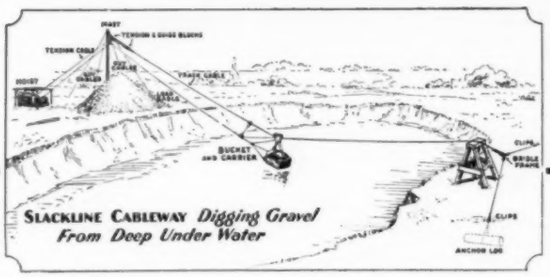


Cletrac Equipped with Revolving Broom

New Bucyrus-Erie Excavator

A new excavator (48-B) has been added to the line of the Bucyrus-Erie Co., South Milwaukee, Wis. The new 48-B is easily converted as shovel, dragline, clamshell, or lifting crane. The dragline-crane boom is built of alloy-steel angle chords with welded tubular cross bracing and is available in lengths from 50 to 100 ft. The high A-frame with special dragline boom-suspension tackle reduces stresses on the boom and lessens the weight at the boom point.

There is a choice of three mountings—standard, oversize, and special oversize. Slide-in cats permit quick shipment on a single car without dismantling. 128 anti-friction bearings are to be found on the 48-B. Centrally located shipper shaft; twin, 42-in., live sheaves, arc-welded outside dipper handles; and a powerful, positive, chain crowd are some of the other outstanding features of the new 48-B.



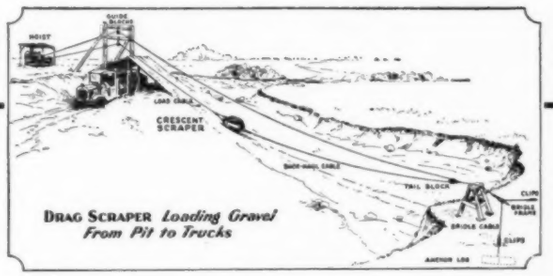
SLACKLINE CABLEWAY *Digging Gravel From Deep Under Water*

Long Range Excavators

Crescent Drag Scrapers and Sauerman Slackline Cableways are low-cost excavators designed to dig and move a maximum yardage of earth with a minimum expenditure of man-power and motive power.

If you are interested in studying new ways of working gravel pits, grading highways, excavating canals, cleaning out reservoirs, and other earth-moving work, send for Catalog No. 17.

SAUERMAN BROS., Inc.
488 S. Clinton St., CHICAGO



DRAG SCRAPER *Loading Gravel From Pit to Trucks*

GRUENDLER CRUSHER & SCREENING UNITS FOR THE ROAD JOB

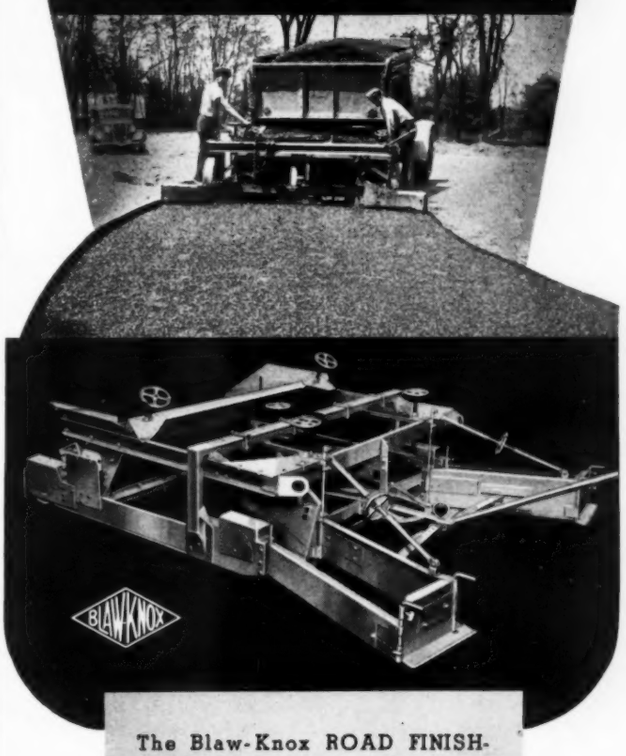
UNIT PLANTS

Portable, semi-portable and stationary units for crushing, screening and conveying in capacities from 100 to 4,000 tons daily. One reduction operations.

Write for Bulletins

GRUENDLER CRUSHER & PULVERIZER CO.
2915 N. Market St. St. Louis, Mo.

Lower Your Costs of Spreading and Finishing Road Materials



The Blaw-Knox ROAD FINISH-SPREADER will spread and finish stone or gravel; hot or cold asphalt—one to fifteen feet wide—half a road at a time. Will lay varying widths on curves fully or partially banked — *with one machine at a fraction of the usual cost.*

Ask Blaw-Knox to send you Catalog No. 1523—"The Blaw-Knox Road Finish-Spreader."

BLAW-KNOX COMPANY
2003 Farmers Bank Bldg., Pittsburgh, Pa.
Offices and Representatives in Principal Cities

BLAW-KNOX *Road* FINISH SPREADER

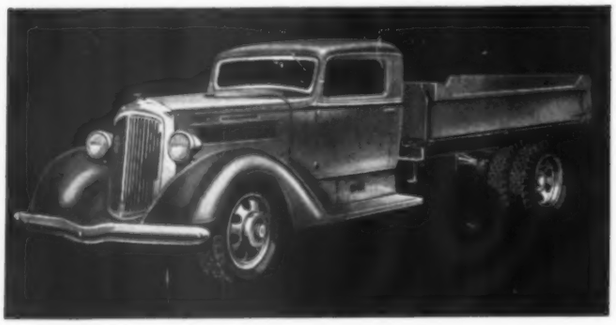
Also in the 48-B, Bucyrus-Erie introduces Perma-Speed control, a new development in smooth and accurate controlling of clutch and brake. Perma-Speed control means that the operator has in his hands at all times safe, sure, and accurate control of every motion of the machine, that the adjustments he makes "stay put" till he changes them, that the conveniently located levers move easily at the touch of a finger, and that fatigue-slow-down need never cut the output.

▼

New Reo Dump Truck

A wide range of rugged dump trucks designed for economical transportation of general building supplies, coal, and like materials, is announced by the Reo Motor Car Co., Lansing, Mich., along with a complete new line of smartly streamlined trucks and buses for 1936.

Heavy frames and big clutches on these new models are built to "stand the gaff" even under most severe conditions. Reo-built transmissions are equipped with standard power take-off open-



New Reo Truck.

ings—one on the smaller models and two on the larger.

Power is supplied by the Reo-built Gold and Silver Crown engines. The full floating rear axles are Reo-built also. For long pulls in creeper gear on steep grades, as in excavation work, 2 speed axle units are available. Correct load distribution is another feature of these 1936 Reos.

Among the many advantages offered this year are optional engines, 5-speed transmission in certain models, 2-speed rear axle and double reduction axle, de luxe cabs, forward drive, and low-price drop-frame models. Certain chassis and equipment are being offered at reduced prices.

▼

WITH THE MANUFACTURERS

Giersbach to Represent FWD in China

Melvin Giersbach left recently for Shanghai, China, to assume his new post as export representative of the Four Wheel Drive Auto Company of Clintonville, Wis., and Kitchener, Ontario, Canada. Giersbach entered the service of the FWD Company over ten years ago. After three years of preliminary training he was brought under the wing of C. S. Thomson, export manager. Since that time, because of his genius for organization and development work he has been kept constantly on the move from one export field to another. Some of his major assignments have been—FWD export representative in Western Canada, the Near East and New York City.

▼

Frank Tuthill Dies

Frank Hall Tuthill, President of the Tuthill Spring Co., Chicago, Ill., died Feb. 24 at his home in Evanston, Ill. Frank Tuthill, with his brother William, organized the Tuthill Spring Co. in 1880. He was president of the company continuously for 56 years.

Mr. Tuthill was much interested in travel, nature study, and civic and church activities. For years he was president of the Chicago Law and Order league. He was a former president of the Prairie club, a deacon emeritus of the First Congregational church of Evanston, and a corporate member of the American Board of Commissioners for Foreign Missions.

He was a gentleman of the old school, whose genial and lovable character made him a host of friends the world over.

Timken Promotions

The Timken Roller Bearing Co., Canton, O., announces the promotion of F. B. Yates to the position of Manager of the New York District Office, in charge of industrial sales. Mr. Yates joined the Timken organization in 1926 after receiving his degree in mechanical engineering from the Sheffield Scientific School of Yale University, spending his first year with the company in the special training course which covered both shop and engineering practice in bearing manufacture and application. After some time in the Chicago district office, Mr. Yates was transferred to the New York District Office in 1928, and now takes charge of that office, where he will continue to specialize in the industrial applications of Timken Bearings. R. W. Powers, a graduate from the engineering college of the University of Michigan in 1931, has been transferred from the Canton Engineering Department of the company to the New York District Office as Sales Engineer, assisting Mr. Yates.

▼

Vulcan Wheels Purchased by American Brake Shoe & Foundry

The assets of Vulcan Wheels, Inc., Avenue L and Thornton St., Newark, N. J., have been purchased by The American Brake Shoe & Foundry Co. The Vulcan Wheels Division of The American Brake Shoe & Foundry Co. has been organized to carry on the business formerly conducted by Vulcan Wheels, Inc. The same staff will be maintained and the business actively conducted for the production and sale of Vulcan Wheels products.

▼

Charles W. East Now District Sales Manager of Republic Steel

Charles W. East has been appointed District Sales Manager of Republic Steel Corporation at Houston, Tex. Mr. East leaves his post as assistant manager of sales in Republic's Pipe Division immediately to establish his headquarters in Houston. As a result of many years of experience in the Birmingham office of Republic, Mr. East will find numerous friends throughout the South who will be glad to learn of his appointment. He succeeds Robert E. Lanier, who has resigned.

▼

Feenaughty Machinery Appointed Link-Belt Shovel, Crane Distributor

Announcement has been made by Link-Belt Co., Chicago, that the Feenaughty Machinery Co. has been appointed distributor for Link-Belt shovels, cranes, and draglines in Pacific Northwest territory. Feenaughty headquarters are in Portland, Ore., with branches located in Seattle and Spokane, Wash., and Boise, Idaho. The organization is headed by W. O. Feenaughty, president; J. I. Overman, vice-president; D. J. Feenaughty, secretary; and F. A. Kingston, sales manager.

▼

George Dandrow Now District Manager for Johns-Manville

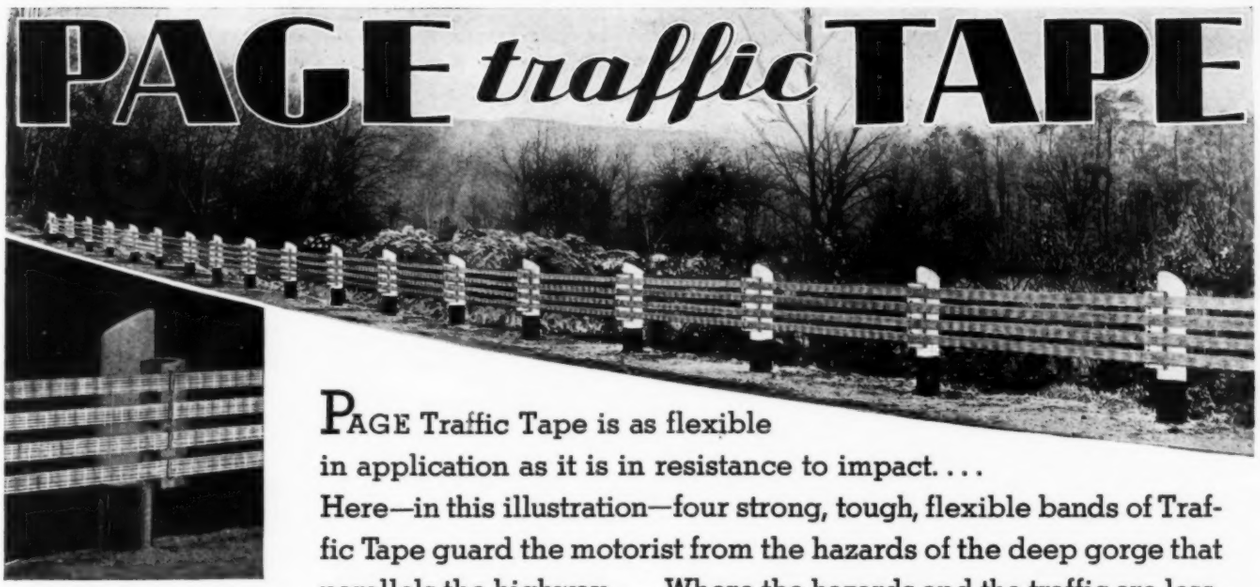
T. K. Mial, Vice President of the Johns-Manville Sales Corporation and General Manager of the Power Products and Industrial Department, has announced the appointment of George Dandrow as Manager of the New York District of this department, with offices at 22 East 40th St., New York City. The appointment became effective on January 15th. Mr. Dandrow joined the Johns-Manville organization in 1922 directly following his graduation from the Massachusetts Institute of Technology where he will be remembered as the inter-collegiate hammer throwing champion and weight thrower on the 1920 American Olympic team. After five years in Johns-Manville's Boston branch, Mr. Dandrow joined the general engineering staff at Headquarters in New York and for the last few years has been Assistant Manager of the New York District.

▼

"Caterpillar" Announces Promotions

M. Rogers has been named general factory manager of Caterpillar Tractor Co. and James R. Munro succeeds Mr. Rogers as factory manager of the tractor division, according to announcement made recently by T. J. Connor, vice-president in charge of manufacture. Both men have been associated with the

PAGE *traffic* TAPE



● Motorists favor Traffic Tape because these resilient bands of steel wire stop cars with a cushioning action. This action not only protects the life of the motorist but assures less damage to his car.

PAGE Traffic Tape is as flexible in application as it is in resistance to impact. . . . Here—in this illustration—four strong, tough, flexible bands of Traffic Tape guard the motorist from the hazards of the deep gorge that parallels the highway. . . . Where the hazards and the traffic are less, ample protection is provided by three or in some cases only two strands. . . . It is this flexibility of application, plus the low cost of erection and maintenance, which appeals alike to taxpayers, highway engineers and contractors. Samples will be sent upon request.

PAGE STEEL & WIRE DIVISION OF THE AMERICAN CHAIN COMPANY, INC., MONESSEN, PENNSYLVANIA

District Offices: New York, Pittsburgh, Atlanta, Chicago, San Francisco

In Business for Your Safety

Easy to
KEEP BUSY

MODEL T-6
25 M.P.H. ROAD SPEED

that's why the MICHIGAN *is a* PROFITABLE INVESTMENT

THERE'S A SCORE OF JOBS waiting for your MICHIGAN TRUCK SHOVEL! It's so fast and flexible that it fits in profitably where the use of heavy, ponderous equipment would be too costly. Yet the Michigan is no "fly-weight". Its rugged unit-construction takes it out of the "shovel-mounted-on-standard-truck" class. From the ground up, Michigan Shovels are balanced—built all the way through for shovel and crane work. Can be quickly converted to clamshell, trench-hoe, backfiller, dragline and skimmer.

Write for Full Description

MICHIGAN POWER SHOVEL CO.
MILLER ROAD,
BENTON HARBOR, MICH.

company for many years, and their advancement reflects the policy of making promotions from the ranks of employees.

Mr. Rogers entered the business in 1922 as foreman of the turret lathe department of the C. L. Best Tractor Co., one of the predecessors of Caterpillar Tractor Co. In 1927, two years after the formation of the present company, he was named assistant factory manager of the Peoria tractor plant. In 1929 he was appointed factory manager where he continued until his present promotion to general factory manager.

James R. Munro

M. Rogers

Mr. Monro enrolled for the four-year apprentice training course at the C. L. Best Tractor Co. in 1918 and upon completion of this work was employed in the tool room. He was made foreman in this department in 1925, and later was in charge of the heat-treating plant in the San Leandro, Calif., factory. He was transferred to the Peoria, Ill., factory in 1931 as superintendent of the new Diesel engine assembly line and assistant superintendent of tractor erection, a post he held at the time of his latest advancement.

Timken Promotion

The Timken Roller Bearing Co., Canton, O., announces the promotion of S. C. Merrill to the position of Eastern District Manager of the Automotive Division, with headquarters in Detroit. Mr. Merrill, a graduate mechanical engineer, Columbia University, 1917, spent several years in the New York territory in production and sales work before joining the Timken organization in 1924. Since then he has been Manager of the New York District Office of The Timken Roller Bearing Co. and during the past year has been handling automotive applications as well as those in the industrial field. His broad industrial and automotive experience gives him the necessary background to handle the specialized problems involved in the automotive field.

S. C. Partridge Advanced by Timken

The Timken Roller Bearing Co., Canton, O., announces the appointment of S. C. Partridge as assistant general manager of the Industrial Division, with headquarters in Canton. Mr. Partridge was graduated from the Engineering School of McGill University in 1925, spending the next four years in the field on engineering work for the government. He joined the Timken organization in 1925, working first in the shop and then in the Engineering Department, where he secured a thorough training in the manufacture of Timken bearings as well as their application to all types of equipment. In 1926 Mr. Partridge was sent to Buffalo, where he had charge of the Timken Industrial District Office for the next two years, going to Toronto in 1928, where he was made manager of the Timken Roller Bearing Company, Limited, in charge of both automotive and industrial sales. His next advance was to the Detroit office of the company, where he assisted Mr. E. W. Austin, General Sales Manager, Automotive Division, which position he has filled until his present appointment as assistant to Mr. W. B. Moore, General Manager of the Industrial Division of the Timken Roller Bearing Company.

Toncan Culvert Manufacturers Association Appoints New Member

The Toncan Culvert Manufacturers' Association, Republic Building, Cleveland, Ohio, has announced the appointment of a new member in the Tri-State Culvert & Pipe Company, Glenwood Avenue, Atlanta, Georgia. The plant will be operated by Mr. L. J. Moore, who has had a wide range of experience in the culvert business. The subject company has sales rights on Toncan iron corrugated pipe, Toncan iron sectional plate pipe and arches, and allied products in the States of Georgia and Florida.

Throng Attends "Caterpillar" Machinery Show

Showing that they had retained the high enthusiasm shown for new equipment at the National Road Show, large delegations of state highway officials, county commissioners and contractors headed for the Machinery Show at Peoria, Ill., as soon as the Cleveland exhibit had answered its final curtain call.

A half million dollars' worth of tractors and road machinery has been placed on display at its Peoria plant by Caterpillar Tractor Co., a major exhibitor at the Cleveland show. The Peoria exhibit will be a permanent one, it is stated, but in spite of this fact, more than 1,500 visitors attended the event during the opening week.

The exhibit is housed in the company's display room, said to be the largest of its kind in the world. This vaulted display room covers almost 40,000 sq. ft. of floor space, and includes a large theater where talking motion pictures are continuously shown during exhibit hours.

The company had invited its distributors to bring groups of highway officials to the show. In response, during the first week, delegations from North and South Dakota, Arkansas, Nebraska, Kansas and Minnesota arrived in special trains. Each group was entertained with a banquet at a leading hotel, and was shown through the factory and foundry. Luncheon was served in the display room. The larger groups were divided into sections, and each of these were assigned hosts and guides.

On display is the company's new Diesel tractor line, ranging from 95 to 35 drawbar horsepower; Diesel and gasoline-powered

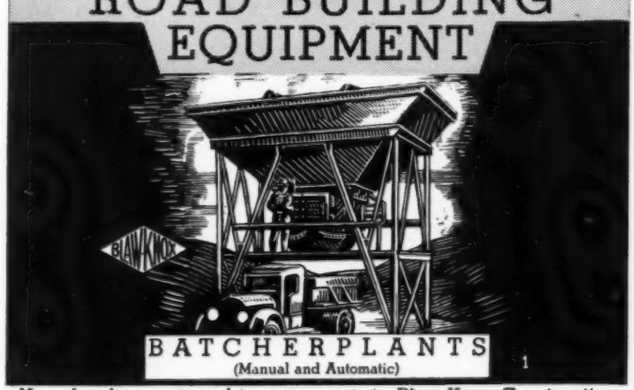
"A COMPARISON"

Compare the condition of early built roads throughout the country and you will find very few dummy joint roads have been rebuilt.

Good joints, good finishing machines, dowel rod and expansion joint spotters.

FLEXIBLE ROAD JOINT MACHINE COMPANY
WARREN, OHIO

BLAW-KNOX
ROAD BUILDING EQUIPMENT

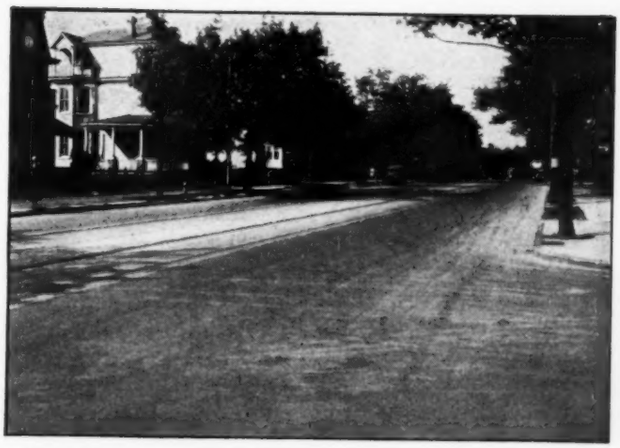


New developments and improvements in Blaw-Knox Construction Equipment are right in step with today's program.

With a background of years of practical experience, Blaw-Knox equipment is trustworthy. It is economical and low in maintenance. Designed to stand up under severe operating conditions, it is fitted to the job by skilled engineers. It helps immeasurably to fulfill contracts speedily and profitably.

BLAW-KNOX COMPANY, 2003 Farmers Bank Building, Pittsburgh, Pa.
Offices and Representatives in Principal Cities

BLAW-KNOX ROAD BUILDING EQUIPMENT
Includes:—
BATCHERPLANTS · ROAD FINISH-SPREADERS (Manuel or Automatic) · TRUKMIXERS
BULK CEMENT PLANTS · Trukmixer Loading Plants
ROAD FORMS · DIRTMOVERS · BULLDOZERS
STEEL STREET FORMS · TAMPING ROLLERS ·
ROAD FINISHERS · CLAMSHELL BUCKETS · (Gas-Electric) · CONCRETE BUCKETS
CEMENTANKS · STEEL BUILDINGS · STEEL GRATING
Literature on any of the above BLAW-KNOX Products will be sent upon application.



Chelton Ave., from Musgrave to Chew St., Philadelphia. Paved with Trinidad Sheet Asphalt in 1922 . . . and still in good condition.

Long life . . . low maintenance costs

This is the proven record of Trinidad Native Lake Asphalt. It is shown in the service given by streets and roads laid or re-surfaced with Trinidad Native Lake Asphalt throughout the United States and foreign countries.

Not only is Trinidad Native Lake Asphalt ideal for new pavements, but old rutty streets and dusty roads can be converted into smooth, dustless highways at minimum cost—for with present foundations of old concrete, brick, granite, or wood-block a new road may be had for the price of an asphaltic top.

It will pay to investigate. Write for information about the outstanding record of Trinidad Native Lake Asphalt pavements.

THE BARBER ASPHALT COMPANY
PHILADELPHIA

New York Chicago St. Louis

AMERICAN ROAD BUILDERS' ASSN. 1902 MANUFACTURER

TRINIDAD
NATIVE LAKE
ASPHALT

Other BARBER Products for Constructing and Maintaining Highways

TRINIDAD LAKE ASPHALT
For Hot or Cold Mix Sheet Asphaltic Concrete Pavements.

BERMUDEZ EMULSIFIED ASPHALTS
Used Cold for Penetration, Pre-Mix Road Mix (Mixed in Place) and Surface Treatment Work.

BARBER BRAND LIQUID ASPHALTS
For Cold Surface Treatment—for Hot Surface Treatment.

BARBER BRAND WINTER COLD PATCH
A Cut-Back Asphalt for Use in Patching and Maintenance Work in Cold Weather.

GENASCO CRACK FILLER
For Maintenance of Concrete Roads.

GENASCO BLOCK AND JOINT FILLER
For Brick and Granite Block Streets. For Filling Joints in Concrete Roads.

CURCRETE
An Emulsified Asphalt for Curing Concrete Highways.

General View of Machinery Show in Display Room of Caterpillar Tractor Co., Peoria, Ill.

auto patrols with newest V-type and one-way snow plow equipment; the 11,000th Diesel engine built by the company, and a wide variety of earth-moving and agricultural equipment built by a number of allied manufacturers.

The precision, export and service sections of the exhibit, the novel mounting of tractors on sidehills and steep grades are features of the show.

NEW LITERATURE

Portable Compressors, Rock Drills, Etc.—A new 32-page catalog has just been issued by Ingersoll-Rand covering its complete line of two-stage, air-cooled portable compressors. In addition to giving complete details of the construction of these units, it is profusely illustrated with views showing the compressors at work on various road and contract jobs throughout the country. Included in the catalog also are illustrations of a large number of the I-R paving breakers, rock drills, and pneumatic tools, all shown in use. A copy of the new catalog (No. 3164) can be obtained from Ingersoll-Rand, 11 Broadway, New York City.

Bethlehem Steel Paving Plates—A four-page illustrated folder No. 354, describes two new types of paving plates, designed for use on roadways, plant floors, loading platforms and docks. Suitable sketches provide instruction details for installation. Copies of this folder may be had from the Bethlehem Steel Co., Bethlehem, Pa.

Stabilized Roads—The principles, design, construction and maintenance of stabilized roads are covered in a 24-page booklet issued by the Pioneer Gravel Equipment Mfg. Co., 1516 Central Ave., Minneapolis, Minn. Contains many interesting illustrations and much useful information. One section is devoted to the plant mix method of constructing stabilized roads. Write the company for your copy.

Two New P&H Excavator Bulletins—The Harnischfeger Corporation of Milwaukee, Wis., has released two interesting new bulletins. The first is a 24-page general catalog covering the entire line of P&H excavators from ⅜ to 4 cu. yds. Attractively printed in two colors and fully illustrated, this general catalog gives condensed specifications on every one of the 22 different P&H gas, Diesel and electric powered machines. The second is a 16-page bulletin devoted to an entirely new machine, P&H Model 765, 2-yd. excavator. Either or both bulletins may be obtained by writing the Harnischfeger Corporation at Milwaukee.

Road Building Equipment—The Jaeger Machine Co., 223 Dublin Ave., Columbus, O., has issued a 60-page catalog of its products, including concrete finishers, combined finisher and spreader, bituminous pavers, road builder (triple pug mill), adjustable spreader boxes, concrete spreaders, steel road forms, subgraders, grade rooters, concrete mixers, road pumps, etc., etc. The catalog contains over 100 most interesting pictures of various machines on the job. In addition there are numerous illustrations pointing out the essential features of the machines. Copies can be obtained by writing the company.

Finish-Spreaders and Concrete Buckets—The Blaw-Knox Co., Pittsburgh, Pa., has issued Bulletin No. 1523 descriptive of its finish-spreaders for road construction and Bulletin No. 1522 descriptive of its concrete buckets. Both bulletins contain much new data that are appearing in print for the first time. Blaw-Knox concrete buckets have been manufactured for the last two or three years, but an effort has been made in the bulletin to make the data complete and of practical value to contractors employing this type of equipment. The Blaw-Knox finish-spreader, a new machine just taken over by the company, is adapted for the spreading of bituminous mixtures in layers from ½ in. to any thickness desired, also for the spreading of gravel, cinders, slag, crushed stone and other road paving material. Address the company for copies of the bulletins.

Use of Rock Salt on Icy Pavements—The International Salt Co., Inc., Scranton, Pa., has issued a bulletin describing the best practices in the use of rock salt for ice removal.

Pressure Distributors and Traffic Line Markers—Two new bulletins, L-14 and L-9, fully illustrating and describing, respectively, the Littleford Model "C" Pressure Distributor and the new Littleford Traf-O-Spray, a new idea in traffic line markers, have just been issued by Littleford Bros., 454 E. Pearl St., Cincinnati, O., from whom copies can be obtained. The Traf-O-Spray cannot only be used as a line-marking machine but it also can be employed for painting stencils, airway directional signs, guard rails, bridges, and other equipment. Write the company for your copies of the above bulletins.

Plant Mixing Calcium-Chloride-Stabilized Soils and Aggregates for Low Cost Roads—A new bulletin on this subject has recently been issued by the Calcium Chloride Association. This bulletin covers the developments up to this time in plant-mixing of stabilized materials, and is divided into sections headed: Plant-mixing of stabilized aggregates; what equipment is needed?; preparation of the aggregate; preparation of the binder-soil; adding the calcium chloride; addition of water; the mixing apparatus; laying the road. A chart showing the correct size gradation of materials and the desired limits of plasticity is also included in the bulletin. A request for Bulletin No. 24, addressed to the Calcium Chloride Association, 4145 Penobscot Bldg., Detroit, Mich., will bring a copy of this latest release to you promptly.

New Development in Valve Design for Compressors—A new development in valve design that promises to be of great importance to air and gas compressor users is the Channel Valve, recently announced by Ingersoll-Rand. To introduce this new valve, Ingersoll-Rand has printed (in their own print shop) a new bulletin, using unique printing methods. A copy of this most unusual bulletin will be furnished on request by Ingersoll-Rand Co., 11 Broadway, New York City.